INCUBATORS
AND
CHICKEN REARERS

HOW TO MAKE AND MANAGE THEM

WRITTEN BY EXPERTS

WITH 124 ILLUSTRATIONS

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PUBLISHERS' NOTE

THIS handbook replaces and supersedes a pamphlet entitled "Incubators and Chicken Rearing Appliances," which, since its first publication upwards of fourteen years ago, has sold in enormous numbers, and has been used as a practical guide to incubator matters the wide world over. The information in that pamphlet, with the exception of a few pages here included, has naturally become out of date, and the present book is published in response to a demand for a cheap but essentially up-to-date and reliable work.

Much of the matter in this handbook consists of contributions by "Leghorn," Wm. Paull, Lionel Hall, and other experts, to "Work," the Illustrated Weekly Journal of Handicrafts. The Editor of that Journal will be glad to answer any questions connected with this book which may be sent to him by interested readers.

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INCUBATORS AND CHICKEN REARERS

CHAPTER I

Principles of Incubation, Natural and Artificial

An incubator is an appliance for artificially incubating eggs. The verb "to incubate" suggests lying upon or sitting upon, this being the means by which a broody hen keeps her eggs warm, the heat of her body, some degrees higher than normal, being transmitted to the eggs. In an incubator, the egg-chamber is kept warm by the heat transmitted to it by hot water or hot air, depending upon the type of appliance employed. Eggs have been successfully hatched out in a very primitive arrangement, consisting of little more than a box warmed by an oil lamp, but as uniform success in artificial incubation depends essentially on close imitation of natural conditions, it follows that a reliable incubator must possess the means of ensuring an equable temperature comparable with that of the broody hen's body, and for this purpose it must be provided with a reliable heater giving a uniform flame, with means of circulating the heat, with a thermometer and with a heat regulator.

INCUBATORS AND CHICKEN REARERS

The advantages of the artificial method of incubation over the old practice of setting eggs under broody hens are so obvious as to have nearly overcome all prejudices. The broody hen is undoubtedly preferable where only a few chickens are reared, but where hatching is on a large scale, or chickens are wanted at seasons when broody hens are scarce, it is absolutely essential to use an incubator.

To operate an incubator successfully, some knowledge is necessary of the nature of the egg, and the changes which it undergoes during the process of incubation. Roughly speaking, an egg consists of four distinct parts, namely, the shell, the membranes just inside the shell, the albumen or white, and the yellow yolk. The shell is porous, and allows of the evaporation of the moisture of the egg. At the large end of the egg is a small air-cell, which, at first not larger than a sixpence, increases as the moisture in the egg evaporates, until at the time of hatching it occupies nearly one-fourth of the interior. On the upper surface of the yolk is the germ-spot, a tiny disk about $\frac{1}{8}$ in. in diameter, containing, if the egg be fertile, a tiny living germ. The yolk floats freely in the white, and in such a way that the germ-spot is always uppermost. The germ is the chick in embryo, and upon its proper development the whole success of incubation depends. It is extremely delicate, hence the necessity for great care in handling and storing the eggs. In winter the eggs should be collected several times a day, to prevent them getting

chilled. Temperatures below 40° F. are usually fatal to the germ, while too much heat is also dangerous. Avoid jarring or shaking the eggs, and store them in bran in a place where the temperature keeps as nearly as possible at 60° F.

For artificial incubation, do not use eggs more than four or five days old. A hen will hatch eggs three weeks old; but an incubator does not invariably give good results with eggs more than a few days old.

There are two types of incubators in general use—hot-water (hydro) and hot-air incubators.

The hot-water incubator has a tank of hot water (heated by a lamp on the circulating-boiler principle), which radiates its heat downwards into the egg chamber. Ventilation is provided for by holes in the bottom and sides of the incubator; and moisture is produced by a tray of water underneath the egg tray, which is usually of perforated zinc.

Hot-air incubators have no water tank, and applied moisture is seldom used. There are two varieties of hot-air incubators: one has a hot-air tank, while the other has no tank at all, the outside air being heated by a lamp as it passes into the incubator, and slowly radiated through the egg chamber by means of porous diaphragms.

The Structure of the Egg

The following information on the structure of the egg and the diagrams (Figs. 1 to 4) are taken, by permission,

from an American work by Charles A. Cyphers. Fig. 1 shows in diagrammatic section the various parts of a fowl's egg, in which A is the blastoderm, or germ-spot, which in a fertile egg has an outer white rim, a circular transparent area within, and inside this again an opacity, whereas in an unfertile egg no such distinct divisions can be seen; B, the white yolk, consisting of a central flask-

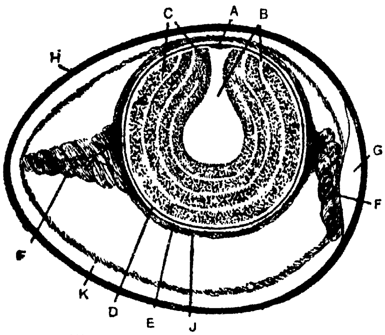


Fig. 1.—Section of Fowl's Egg

shaped mass and a number of layers concentrically arranged around it, the outer layer of white yolk lying immediately beneath the vitelline, or yolk membrane, and connected with the central mass beneath the blastoderm; C, the yellow yolk; D, the vitelline or yolk membrane; E, a layer of more fluid albumen surrounding the yolk; F, the chalaze, two twisted cords of albumen, which keep the yolk more steady in the albumen, and moderate the effects of shock; G, the air chamber between the two layers of

the shell membrane; H, the shell, consisting of inner and outer porous layers, on the inner side of the former being a thicker outer membrane and a thin inner one which tend to separate at the broad end of the egg and form a space, G, in which air accumulates; J, denser albumen (the "white" of the egg), which extends around the yolk outside the internal layer of more fluid albumen; K, the

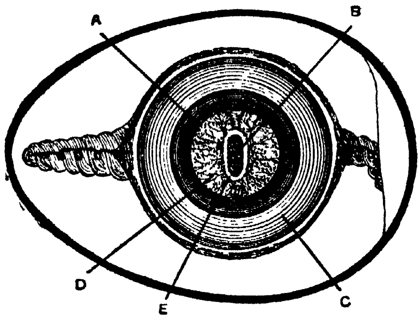


Fig. 2.—Section of Egg after 48 hours' Incubation

boundary between the outer and middle portions of the albumen.

During the descent of the egg along the oviduct of the fowl, where it is exposed to a temperature of 110° F. or more, the germ-spot undergoes changes which are arrested when the egg is cold, only to be renewed under the influence of the higher temperature of incubation. Owing to the lower density of that part of the yolk immediately surrounding it, the germ-spot is always found uppermost, provided

the yolk is free to rotate. The yolk, too, is lighter than the albumen in which it is immersed, but the pressure of the germ-spot against the shell is moderated by the weight of the chalaze F (Fig. 1).

The Development of the Embryo

A fowl's egg, after about 48 hours' incubation, is shown in Fig. 2, the view being from above, and not a vertical section as in Fig. 1. The germ-spot, which at first lies with its margin on the circular wall of the flask-shaped white yolk (see Fig. 1), spreads out, when incubation begins, and forms a thin circular sheet over the yolk, ultimately, and at a late period, completely enveloping it In Fig. 2, A indicates the area opaca, the portion of the germ-spot which extends as above described; D, the vascular part (from which form the blood-vessels) of the area opaca, and E, the area pellucida; both D and E grow, but not so fast as A. The embryo B is in the centre of the area pellucida, C is the yolk.

During the first twelve hours of incubation the germ-spot, when viewed from above, is found to increase greatly in size. The central white spot, or pellucid area, becomes oval in outline and distinct. During the latter part of the first day is seen the first definite appearance of the head. At the beginning of the second day the head alone projects above the rest of the germ, the remainder of the embryo being simply a part of a flat germ-spot. At about the

twenty-sixth hour the tail makes its appearance, being raised above the level of the germ-spot in the way that the head was raised. The first rudiment of the head appears about the twenty-seventh hour, and is of a tubular character, being formed by a longitudinal fold of the vascular layer. For some time it is undivided, being simply a long tube extending through nearly the whole

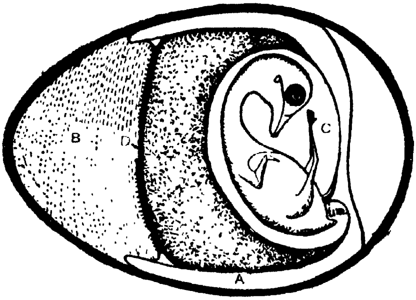


Fig. 3.—Section of Egg after 11 days' Incubation

length of the embryo. Although the development has proceeded thus far at about the thirty-fifth hour, no motion is seen in the heart or vessels until the thirty-eighth or fortieth hour.

Between the fortieth and fiftieth hours a separation of the heart in parts may be observed, and between the fiftieth and sixtieth hours the circulation of blood in the vascular area becomes more vigorous. The blood-vessels become connected during the latter part of the second day, so as to form a complete system through which the

blood definitely circulates. By the end of the third day the area opaca of the germ-spot is spread over about half the yolk; the vascular area is much smaller than the area opaca, and still smaller is the area pellucida, in the centre of which is the rapidly growing embryo. During the third day a remarkable change takes place in the position of the embryo. Up to this time it has been lying symmetrically upon the yolk with the part which will be its mouth directed downwards. (If an egg be placed with its broad end to the right of the observer, the head of the embryo will in nearly all cases be found pointing away from him. Out of 166 examined, Duval found 163 in this position.) It now turns round so as to lie on its left side. This change of position is almost invariably completed on the third day. Coincidentally with the change of position the whole embryo begins to curve on itself; this curvature of the body becomes still more marked on the fourth day.

At the middle or end of the fourth day, the embryo is found to have greatly increased its size, and to be lying in almost immediate contact with the shell membrane. The blood is circulating more actively. The tail, first noticeable on the third day, has become a conspicuous feature of the embryo, which has become more curved upon itself. The distinct appearance of the limbs must be reckoned as one of the most important events of the fourth day. The allantois (an appendage of the alimentary canal)

becomes conspicuous for the first time on this day, though its rudiments appear on the third; it may be recognised as a pear-shaped vesicle, connected with the under surface of the alimentary (feeding and nourishing) canal by a long hollow stalk. It does not, during the third day, project beyond the body of the chick, but on the fourth it begins to pass out on its way to that space between the external

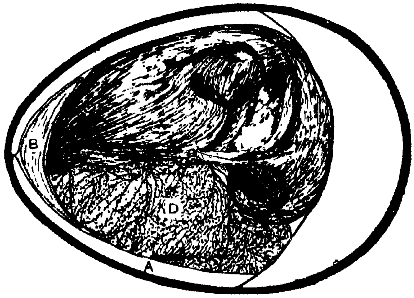


Fig. 4.—Section of Egg after 16 days' Incubation

and internal folds of the amnion. In this space it spreads out and eventually encloses the whole contents of the egg beneath the shell membrane A (Fig. 4). On the first half of the day it is very small, and its growth is not very rapid; in the latter half of the day its growth becomes more rapid. There are no new features to record on the fifth day; the embryo remains excessively curved—so much so, indeed, that the head and tail are nearly in contact. The amnion at its complete closure on the fourth day very closely invested the body of the chick; the true

cavity of the amnion was then, therefore, very small. On the fifth day fluid begins to collect in the cavity, and raises the membrane of the amnion to some distance from the embryo. The cavity becomes still larger by the sixth day, and on the seventh day it is of very considerable dimensions, the fluid increasing in it.

By the sixth or seventh day the flexure of the body has become less marked, so that the head does not lie so near to the tail as on the previous days, and at the same time a more distinct neck makes its appearance. Though the head is still disproportionately large, its growth now ceases to be greater than that of the body. By the seventh day very obvious movements begin to appear in the amnion; its slow vermicular contractions creep rythmically over it. The amnion, in fact, begins to pulsate slowly and rythmically, and by its pulsation the embryo is rocked to and fro in the egg. The allantois has grown rapidly and now forms a flattened bag, filled with fluid, covering the right side of the embryo. The yolk is not so fluid as on the sixth day, though it continues to absorb the white of the egg, which is diminishing rapidly. During the eighth, ninth, and tenth days the amnion does not undergo any very important changes. Ossification (the changing of the flesh into bone) begins on the eighth or ninth day. On the eighth day a chalky-looking patch is observable on the top of the nose. This, by the twelfth day, will be developed into horny but still soft beak,

)n the thirteenth day nails will be visible at the extremities, and scales on the remaining portions of the toes. hese on the sixteenth day will become harder and more orny, as does also the beak. By the thirteenth day the artilaginous skeleton will be completed, and the various nuscles of the body can now be discerned with tolerable learness.

As early as the ninth or tenth day the sacs containing he feathers begin to protrude from the surface of the back s papillæ, especially prominent at first along the middle ine of the back, from the neck to the rump and over the highs, the sacs of the tail feathers being very conspicuous.)n the thirteenth day these sacs, being generally distributed over the body, and acquiring a length of ¼ in. or more, appear to the naked eye as feathers, the thin walls f the sacs allowing their contents, now coloured according o the breed of the bird, to shine through. They are still, owever, closed sacs, and, indeed, remain such even on he nineteenth day, when many of them are of considerable ength.

Fig. 3 shows the egg after eleven days' incubation. is the cavity of the allantois; B, the albumen; C, the avity of the amnion; D, the umbilicus, or small hollow ube connecting the embryo with the amnion, yolk-sac, nd allantois.

By the eleventh day the abdominal walls, though still ooser and less formed than the walls of the chest, may

be said to be definitely established, and the loops of intestine, which have hitherto been hanging down, are drawn up into the abdomen. The body of the embryo is therefore completed, but it still remains connected with its various appendages with a narrow umbilicus D (Fig. 3), in which run the stock of the allantois and the solid cord suspending the yolk-sac. The allantois, still growing rapidly, completely surrounds the whole contents of the egg, except at the pole opposite to the embryo, where for some little time a small portion of albumen remains unenclosed; at this spot the diminished white of the egg adheres as a dense viscid plug.

As early as the sixth day movements may be seen in the limbs of the embryo upon opening the egg. They cannot, however, be of any great extent until the fourteenth day, for up to this time the embryo retains the position in which it is formed—namely, that with its body at right angles to the long axis of the egg. On the fourteenth day a definite change of position takes place; the chick moves so as to lie lengthwise in the egg, with its head opposite the chorion and shell membrane, where they form the inner wall of the rapidly increasing air-chamber at the broad end. By the eighteenth day the fluid in the amniotic sac, in which the embryo lies, has entirely disappeared, and the chick is breathing the air which it contains. The pulmonary circulation, which has been gradually developing since the third day, increases in

activity, and the circulation of blood in the allantois correspondingly diminishes.

The fowl's egg sixteen days incubated is shown by Fig. 4. A is the cavity of the allantois. The allantois now completely envelops the embryo and yolk-sacs, and the remaining portion of albumen, B. The amnion is losing fluid, and very closely envelops the embryo, while the yolk D is seen folded over it. The allantois becomes thinner and thinner as incubation progresses, so that at the last its two walls lie in direct contact, the fluid and cavity entirely disappearing. On the nineteenth day the yolk-sac, diminished greatly in bulk, is withdrawn through the umbilicus into the abdominal cavity, which it largely distends. Outside the embryo there remains nothing now but the highly vascular allantois and the practically fluid-less amnion.

By the twentieth day the fluid in the allantois has entirely disappeared, and the chick now thrusts its beak through its coverings and breathes the outer air. In from six to ten hours from the time of first breathing the outer air, the chick, breaking the shell around the broad end of the egg with rapid blows of its beak, casts off the dry remains of the amnion and allantois, and quits the shell.

Essentials in Artificial Incubation

Only by close study of the instinctive actions of the sitting hen can the essential conditions of artificial incu-

bation be understood and obtained. There is quite a number of special points which must be borne in mind by both the maker and user of an incubator.

The hen, in a state of nature, forms her nest on the ground in a secluded spot—frequently under a hedge. The heat of her body draws moisture from the ground and thus renders the air around the eggs more or less humid. Probably, also, in her daily perambulation in search of food, the breast feathers become wetted with the dew upon the grass, and this also adds moisture to the surfaces of the eggs, which during the hen's absence have become cooled and received an airing. Before settling down to sitting again, the hen often shuffles the eggs about with her beak, as if to make her hard bed more comfortable.

It is but fair to say that there is controversy as to the exact means by which the moisture is supplied to eggs in course of natural incubation. Hens are known to make nests in old carts, etc., under sheds, and, of course, thousands of wild birds build their nests high up in trees, so that the possibility of moisture being derived from the earth is out of the question. Many experts believe that the whole of the moisture comes to the eggs from above—from the hen's breast feathers chiefly—and they construct their incubators accordingly.

From the facts already stated, it is possible to arrive at certain conclusions as to essential conditions to be

provided. The natural heat of a hen's body, in health, is about 98° F. (blood heat); but when the brooding instinct, rightly termed a fever, affects her, the natural heat is increased, and is given by different authorities as ranging between 100° and 106° F.

The heating of the incubator, then, should be arranged so that the temperature neither exceeds 106° nor falls below 98°. The happy mean is between these points, and probably the safest heat at which to work will be 104° F., this allowing for a slight increase without much danger of fatal results following, provided the excess is not long continued. Special attention is here drawn to the fact that the germ will stand a prolonged *lowering* of temperature much better than an increase. If the increase of heat is severe or long extended, it will generally prove fatal; a decrease of heat, under like conditions, tends but to delay somewhat the time of hatching. In whatever position the egg may be lying, this life germ always floats at the top, where it receives the greatest amount of heat. It is, therefore, of the highest importance that perfect accuracy of temperature be secured and maintained; and to this end a reliable thermometer is a prime necessity. It should be specially made for incubator work, with the scale engraved indelibly on the stem. It must be fixed in the incubator, so that the upper surface of the bulb is level with, or but slightly below, the tops of the eggs. A little time spent in arranging this to a nicety will not be wasted,

Ventilation and moisture will be considered together, as the one depends somewhat upon the other. The shell of an egg is porous, and the natural inference is that it is so for the admission of air to the growing chick; but, as the lungs are not developed until a somewhat advanced stage of incubation, a large supply cannot be required during the previous period. Presumably, also, it is porous for the admission of a certain amount of moisture. In this connection it may be noted that barometrical changes are probably a much more important factor in success or failure than is generally imagined. It certainly stands to reason that, with a low barometer, when the atmosphere is charged with abundant moisture, there is not much danger of the supply inside the incubator being insufficient, and probably an excessive supply may be harmful to the well-being of the embryo chick. On the other hand, when the barometer ranges high, and the air is dry, it is well-nigh impossible to overdo the artificial supply of moisture.

The heat supply should be arranged so that as little work as possible is thrown upon the regulator; the chief purpose of an incubator regulator is to compensate for the variable temperature of the atmosphere, and all rough adjustments should be made by regulating the size of the lamp flame. Care should be taken that the necessary moisture is maintained; that the eggs receive daily a cooling and an airing, such as they would get under natural conditions: and that they are turned so as to prevent

the germ, which always floats at the top of the egg, from becoming fixed, thereby hindering or entirely arresting development. The egg is to be turned at least once a day, so that the germ occupies a different position in the shell. Shifting the eggs also tends to compensate for any slight inequalities of temperature which may exist in different parts of the egg chamber, by ensuring that each egg shall in turn occupy each and every part. A daily exposure of the eggs to the atmosphere (but out of a draught) for a period of from ten minutes in cold weather to twenty minutes in the warmest weather will suffice for airing.

An incubator should be worked in a room where it will not be subjected to draughts or to sudden or great changes of temperature. Do not allow loud noises in its neighbourhood; do not handle the eggs roughly or frequently; and do not open the incubator more than is absolutely necessary, especially near hatching time. Keep the lamp well supplied with good oil, and trim the wick at least every twenty-four hours; and an hour after relighting make any necessary adjustment of flame.

An important matter is the selection of the eggs to be used in an incubator. It often happens with some breeds or strains of birds, in consequence of the natural tendency to "throw back" in the progeny, or to revert to an inferior type if totally fresh blood is introduced, that continued close and in-breeding is resorted to; as a consequence, the germs are weakened, and though under hens

the eggs may develop into living birds, in incubators they may prove failures. But the crossing of specimens of two distinct breeds, whilst it may cause a reversion to an inferior type for exhibition purposes only, will wonderfully increase the vitality of the germ and resultant chick.

The eggs most suitable for artificial incubation, therefore, are those from first crosses—where the parents on either side are pure bred; but when a fair measure of success is attained with these, attempts may be made with eggs from highly-bred pure breeds with greater chances of success. To procure from shops "new-laid" eggs of doubtful freshness, and in ignorance of the conditions under which they were produced, is but to court failure, and still more so is it to fill up the incubator with foreign eggs.

The eggs should be the produce of hens, *and not of pullets*, mated, by preference, with a vigorous cockerel; they should be of uniform size, all abnormally large or small ones, and those of irregular shape, being rejected.

The necessary periods for the incubation of eggs, *both with the natural and artificial methods*, are as follows:—Hen, twenty-one days; pheasant and partridge, twenty-four days; duck and turkey, twenty-eight days; goose, thirty days. Some varieties of ducks—those approaching more nearly the wild state—also take thirty days.

CHAPTER II

An Approved Pattern of Hydro Incubator

This chapter will describe and illustrate the construction of a type of hydro or hot-water incubator, which has served as a model for manufacturers all the world over, and which has remained of substantially the same design

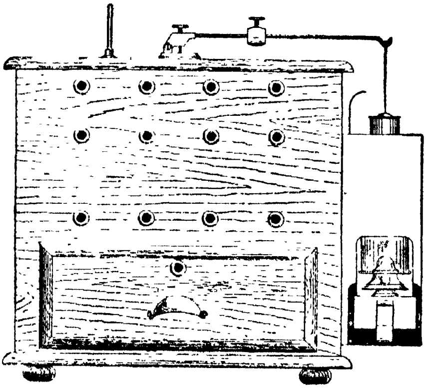


Fig. 5.—Front Elevation of 50-Egg Hydro Incubator

for between twenty and thirty years. It is based on a well-known Hearson type—the "Champion"—and it may be noted that Charles Edward Hearson's incubator, of which the provisional specification was lodged in the British Patent Office on November 24th, 1881, and the complete

specification on May 23rd, 1882, quickly came into high repute, chiefly because the inventor happened to hit upon what was at that time the only reliable regulator for maintaining uniform heat in the egg chamber. His capsule regulator is still the most popular type on the market.

A 50-egg Hearson-type incubator, with drying box, is shown by Figs. 5 to 10, under each figure being an explana-

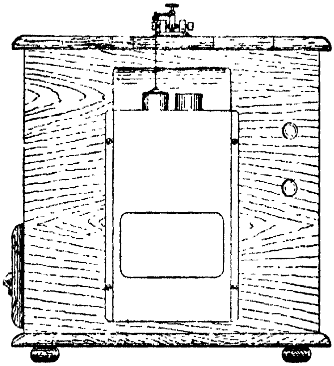


Fig. 6.—End Elevation of 50-Egg Hydro Incubator

tory inscription. The outer case is made of ¾-in. yellow pine, in the form of a square box 20 in. long, 20 in. wide, and 17½ in. from the top of the base-board to the underside of the top, dovetailed at the corners. Both base and top are also of pine, with the edges rounded, the base being in one piece. The top—apart from the glazed lid at the front—is in narrow widths, secured by round-headed brass screws, with washers under their heads. The opening

or the drawer, 15½ in. long and 5 in. high, is cut in the front of the case, 1 in. above the top of the base-board. On a level with the bottom of this opening is fixed the inner floor, on which the drawer slides. As shown, there is a ½-in. space between the inner bottom and the base for ventilation purposes, the air passing in through four holes

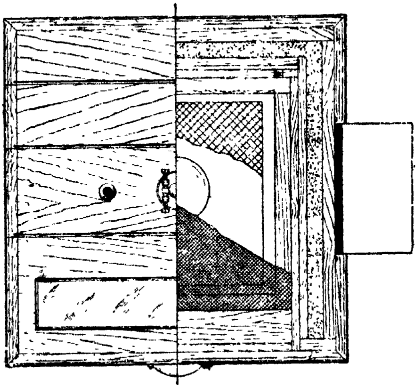


Fig. 7.—Part Plan of Lid and Part Horizontal Section through Egg Chamber

bored in the corners of the base, and finding its way into the egg chamber through a central hole in the inner bottom.

The water tank is 17 in. square and 4 in. deep, and is made of copper; it is traversed by a flue 1¾ in. in diameter and 13 in. long from the outside of the water jacket, which extends to the outside of the case. The return flue is ⅝ in. from the other, and the two are arranged to occupy a central position, widthways, in the tank. Where they pass

through the woodwork of the case and the packing, the flues are encased in a water jacket 4¾ in. wide, 2⅜ in. deep, and 1½ in. long, the upper corners of which are quadrant shaped.

There is a false bottom, which may be of perforated zinc, arranged about ¾ in. from the bottom of the tank.

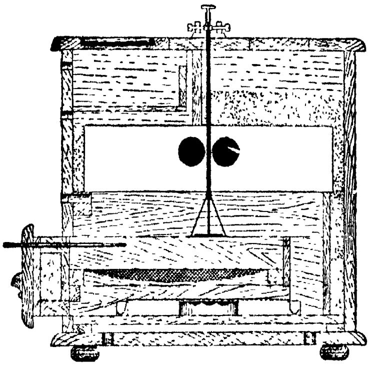


Fig. 8.—Vertical Cross Section through Centre of Incubator, with Drawer partly drawn

Between the top of the tank and the underside of the lid there is a space of 4¾ in., and, 8¾ in. from the inside of the front of the case, this space is partitioned off by a ⅜-in. board running right across the case, and this forms a drying box for the newly hatched chickens. As seen in Fig. 8, a floor, ⅜ in. thick and 7¾ in. wide, is fixed, distant 3½ in. from the underside of the lid; this allows a space of about ⅞ in. between the lower side of the floor and the top of the tank; to the edge of this floor a ½-in. upright,

in. wide, is fixed, and along the upper bank edge of this
pright piece a strip of coarsely perforated zinc is tacked.
In Fig. 5 three tiers of ventilation holes are shown, each
ole being furnished with a ½-in. brass eyelet; those in
e lower row serve as outlet ventilators for the egg
amber—the inlets being through the base, as previously

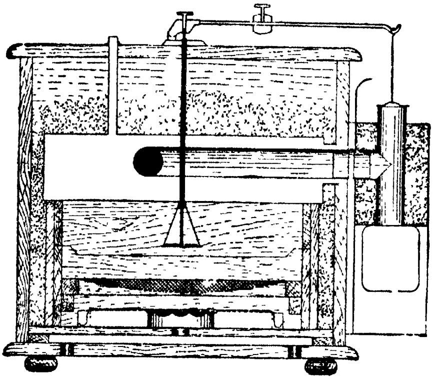


Fig. 9.—Longitudinal Section through Centre of Incubator

entioned. A similar row of holes is provided at the back
the case, although they are not shown in Fig. 8. The
iddle row of holes serves as inlets for fresh air, which is
armed as it passes over the tank, and passed between
le partition and the 2½-in. upright piece, through the
rforated zinc, into the drying box, finally escaping, laden
ith the moisture from the drying chicks, through the
pper row of holes. The glazed lid, forming the front
rtion of the top, by which the chickens are introduced

and removed, fits over the drying box, and is not fixed, but is kept in position by small fillets tacked to the underside.

The opening which takes the egg drawer is 15½ in. wide, 17¾ in. from the front of the case to the partition supporting the tank, and 7¾ in. high from the surface of the inner floor to the bottom of the tank. The egg drawer is

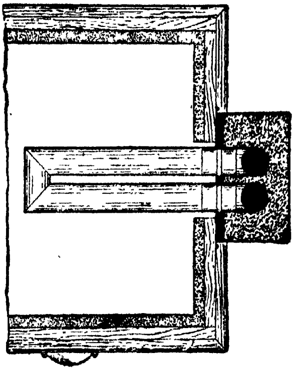


Fig. 10.—Part Sectional Plan of Incubator through Tank

an easy fit in the 15½-in. by 5-in. hole cut in the front of the case, and is 17½ in. long from inside the false front, which, as will be seen, overlaps the drawer opening about ⅜ in. all round. The inside measurement of the drawer is 14½ in. square. The wood frame, which is covered with perforated zinc, and forms the bottom upon which the eggs rest during incubation, allows a space of 1⅞ in. round the sides of the drawer, and the concavity of this zinc

ottom allows the eggs in the centre of the drawer to be in. lower than those at the extreme sides.

For noting the temperature of the egg drawer, a hole bored through the drawer front; outside it is bushed ith a brass eyelet, and inside it is fitted with a paste- oard tube of about ⅜ in. internal diameter, which projects ½ in. inside the drawer. The centre of this hole is ½ in. elow the drawer top, and, when in use, the thermometer ulb projects slightly beyond the inner end of the paste- oard tube, and is thus in the correct position for recording he heat reaching the whole of the eggs, the concavity of he bottom of the egg drawer compensating for differences f temperature which exist between the centre and the utsides of the egg chamber. The zinc water tray beneath he egg drawer is 12½ in. square, with sides 1 in. high and hole 4 in. diameter in the centre. The inner inverted ray of coarsely perforated zinc which supports the damping anvas is 11 in. square and 1 in. high. Over this zinc upport a double thickness of coarse canvas is used, and ips all round in the water contained in the tray, so all ir passing into the incubator is filtered through the wet anvas and moistened in its passage. A single thickness f the dry canvas is used under the eggs in the egg rawer.

The heat-regulating apparatus, which includes a capsule, fully described in Chapter VI. The bottom of the tripod, pon which the capsule rests, is 2⅞ in. from the bottom

of the tank, and the needle tube which supports the tripod is arranged in the centre of the egg drawer.

The heating arrangements consist of a lamp box, 13 in. high, 8 in. wide, with a projection of 5 in. of which ½ in. consists of an air space between the lamp box proper and the side of the case. The upper portion of the lamp box, to a depth of 6¼ in., contains in the front portion a ┤-shaped inlet flue, and in the back portion a ┘-shaped outlet flue, both 1¾ in. in diameter. The flues in the lamp box are embedded in some non-conducting composition to connect them with the flue traversing the tank, a couple of nipples or connectors are employed, 2¼ in. long, and of such diameter that they are a good fit in the flues, a reeded band being raised about the centre of each connector to prevent it being pushed wholly into one portion of the flue. Both inlet and outlet flues extend 1 in. above the lamp-box casing; and, to protect the woodwork of the incubator the back of the lamp box is extended upward 2¾ in. to form a shield, and the upper end is bent outwards to the extent of 1 in.

The lamp which supplies the heat is a rectangular vessel made of tinplate, 8 in. long, 4 in. wide, and 2 in. deep, mounted on and hinged to the back of a ⊔-shaped casing of similar dimensions, but 3 in. deep. Beneath the lamp at the front end, and fixed to the bottom of the casing, is a spiral spring; in order to keep the spring in check, a square wire loop is hinged to the casing and

passes over a catch soldered to the lamp reservoir. The burner is of the flat-wick type, but of somewhat special construction, obtainable from dealers in incubator fittings; it takes a $\frac{3}{4}$-in. wick, and is fitted with a gallery to accommodate a glass cylinder chimney, about 3 in. long and $2\frac{1}{2}$ in. diameter, which serves as a connection between the lamp burner and the inlet flue in the lamp box. To place the lamp in position, the spring is depressed so as to allow the glass cylinder to pass into the opening in the front of the lamp box, on the bottom of which the lamp slides. When the lamp is pushed quite home the spring is released, and the glass cylinder then beds itself against the bottom of the upper portion of the lamp box so that the burner is immediately below the opening of the inlet flue, whilst the spring exerts its influence to keep the glass tightly in place. When the lamp requires to be trimmed or replenished with oil, it may be easily withdrawn by first depressing the spring.

For packing between the egg chamber and the case, and also round the tank, ordinary sawdust is employed, as indicated in the illustrations, and as these are strictly to scale, all minor measurements may be taken from them.

Modifications and Suggested Improvements

In a modified form of the incubator above described, in the first place, the drying box is done away with—not because it is of no use, but because a foster-mother,

described in Chapter IX., serves not only as a drying box, but also as a nursery in which to keep the chickens for the first few days of their existence before they are strong enough to be turned out into a rearer. There being no drying box, the height of the incubator between base and lid is reduced from 17½ in. to 15 in. in this machine, still

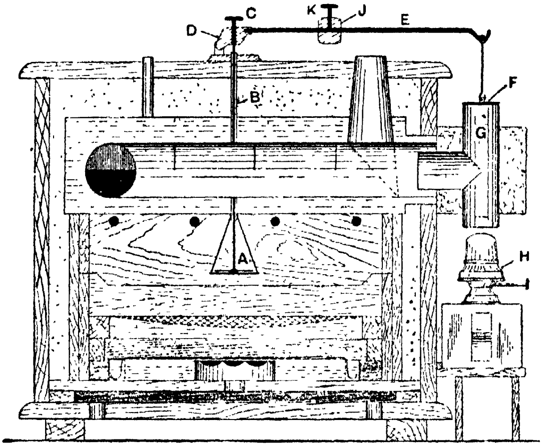


Fig. 11.—Longitudinal Section through Modified Hydro Incubator

allowing for 2 in. of cork-dust packing above the tank. Fig. 11 is a longitudinal section through the modified machine (the reference letters are explained in Chapter VI.)

The principal alteration and improvement will be found in the tank. This is 17 in. square, but 4½ in. deep, and is traversed by a flue, 2½ in. diameter, which is "baffled" at intervals throughout its length (*see* Fig.12). In this

incubator as large a flue surface as possible is exposed, and the return flue, instead of being passed out at the side and into the lamp box, is turned upward near the end of the tank and passed out through the lid. The lamp box is constructed on similar lines to that shown by Fig. 13, and is $4\frac{1}{2}$ in. square on plan and 4 in. high, and contains, quite centrally, a $1\frac{3}{4}$-in. ⊣-piece or inlet flue, packed tightly in silicate cotton. The

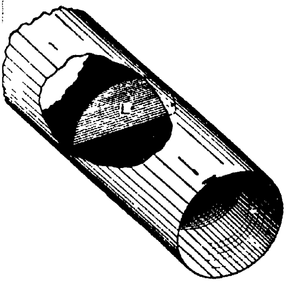


Fig. 12. Portion of Heating Flue, showing Baffle

lamp is a rectangular vessel 7 in. long, 4 in. wide, and 3 in. deep, upon which is mounted a "Silver" chimneyless burner taking a $\frac{5}{8}$-in. wick.

In this connection it may be worth mentioning that the collars into which the "Silver" burners screw are the same size for both the $\frac{3}{8}$-in. and $\frac{5}{8}$-in. sizes. In any lamp more perfect combustion is obtained when the flame is turned up as high as possible

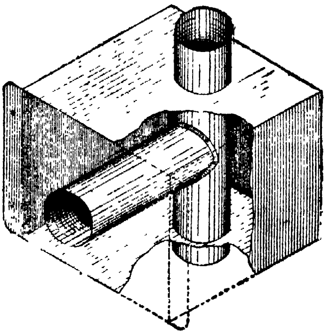


Fig. 13.—View of Lamp Box cut away to show Flue

without smoking. It is advisable to procure a burner of each size for this incubator, because a burner taking a $\frac{3}{8}$-in. wick is not powerful enough to keep up the requisite heat in cold weather; yet in hot weather it is almost impossible to keep a small enough flame in a $\frac{5}{8}$-in. burner, without a waste of heat; and when the flame is turned very low, a slight smell of unburnt petroleum vapour is perceptible, which, if not injurious, is at any rate unpleasant. (As a matter of fact, with incomplete combustion carbon *mon*oxide instead of the *di*oxide is formed, and this is distinctly injurious.) This arrangement of lamp and flues will be found very economical.

Details of the regulator, ventilation, and damping arrangements, also of the egg drawer, are the same as already described, with the exception that, as the flue passes round the outer part of the tank instead of being in its centre, the heat from the tank is less central, consequently the egg drawer may be less concave. A nearly flat bottom to the egg drawer is desirable, but, if it is quite flat, the central eggs will get more heat than those nearer the outside. In the present instance, a dishing to the extent of $\frac{1}{2}$ in. will suffice. The loose shutter will be found a great convenience, especially at hatching time, as it is possible to ascertain the state of the eggs without pulling out the drawer, with the consequent lowering of temperature. Also, should a chick get hung up in the regulator

:ipod—a not uncommon occurrence—it can be moved revious to pulling out the drawer, thus avoiding maiming , or the breaking of one or more eggs—a likely consequence hen the cause of any obstruction cannot be seen, as is he case with a solid-fronted drawer.

CHAPTER III

An Easily Made 100-Egg Incubator

FIG. 14 shows an easily made 100-egg hydro incubator (with the front out) much as it should appear when ready for use. A is the tank; B is the regulating screw with damper rod and bracket; C is the drying box; D the hot-air tube; E the capsule and its stand; F the drawer front; G the moisture tray; H the circulator; J the lamp and tray; and K is the silicate of cotton packing.

No incubator will be found satisfactory unless it is constructed with an inner and outer case, since the atmosphere coming directly on to the eggs from the ventilation holes is injurious, as the eggs round the edge of the drawer frame will be found to be at least 4° F. cooler than those nearer the centre. For a 100-egg incubator, the outer case should be made of ¾-in. seasoned pine 22 in. square inside, the height, including top and bottom, being 18¾ in. The hole in front for the double-fronted drawer should measure 18 in. by 8 in., and the drawer front must be the full width of the machine, viz., 23½ in. by 9½ in., so that when closed the whole space in the outer case is covered. This drawer front having no stay may warp slightly, and to prevent this, insert in each end a piece

pine the opposite way to the grain of the drawer front, d 9½ in. by 1½ in. by ¼ in. To insert this piece, two ts with a tenon saw ¼ in. apart and 1½ in. deep must be ide in each end of the drawer; then pass down a ¼-in. mer chisel, which will remove the piece.

The most durable method of putting the case together dovetailing. The dovetails must fit tightly, and be put gether with thin glue, or they will be useless. The top and

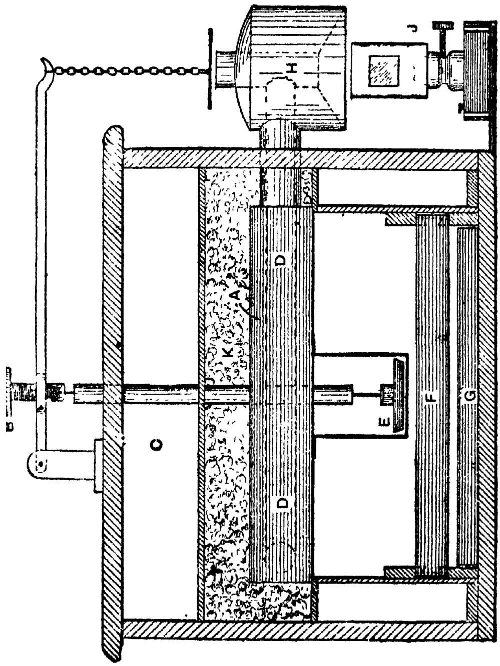


Fig. 14.—Longitudinal Section through Easily-made 100-Egg Incubator

bottom must be screwed on, the screws being about 3 in apart.

Ventilation holes in the outer case should be bor 4 in. apart, 2½ in. from the bottom of the tank, and ½ i in size. A fillet of wood, ¾ in. thick, should be nailed each side on the bottom. The inner case should be 18 in square, and 8 in. high, and should be screwed or nail to the fillets fixed in the floor of the machine. Befo fixing the inner case, set out the ventilation holes to co

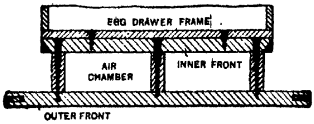


Fig. 15.—Section through Drawer Frame and Air Chamber

between the holes in the outer case; this is easily do by placing the inner case in position, and passing a pen through the holes already drilled to mark the inner ca Then drill the holes exactly midway between the mark and thus the necessary amount of ventilation is obtain and draught is avoided.

The drawer front for the inner case, 18 in. long an 6 in. wide, must fit flush with the inner case. This is simpl a square wooden frame, and the bottom of the outer ca forms the bottom of the inner one also. A fillet, 1½ in. b ½ in., must be fastened on each side of the inner case the bottom, and on it runs the egg drawer. Another fill

ıld be fixed 2 in. above it on each side, so that the drawer, which must be 2 in. deep (barely), will slide nd out easily.

The egg drawer is 18 in. wide by 17¼ in. (barely) from k to front, thus allowing ¾ in., so that the inner drawer ts flush. The inner drawer front will be 18 in. wide

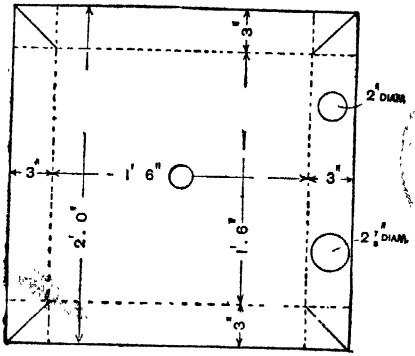


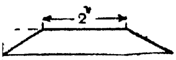
Fig. 16.– Pattern for Hot-water Tank

6 in. deep, and it is screwed to the drawer frame. ree blocks of wood 6 in. long, 2¾ in. wide, and 1 in. ck are placed between the inner and outer front, a 4-in. ew passed right through each block from the inside the inner front and gripping the outer front to the awer frame; *see* Fig. 15.

The egg drawer frame should be dovetailed at the rners, and a 1-in. equilateral triangle of wood should glued and tacked in each corner. The bottom of the

frame should be covered with perforated zinc with holes, and tacked on to the frame with ½-in. copper ta It should be stretched as tightly as possible to give rigidity. The tank and hot-air pipes should be made of 6 sheet copper (the weight is that of a sheet 4 ft. × 2 ft). T bottom and sides are made from one piece, and the corne are cut and lapped as in Fig. 16. The piece is cut to t full lines, and bent on the dotted lines at right angl The corners will then lap, and must be well soldered outsi and inside. To the ⅜-in. hole in the centre a piece of copp tube 4 in. long is soldered. The 2-in. and 2⅞-in. ho for the hot-air pipe should be cut while the sheet is in th flat, and the holes in the outer case should be cut whe the tank is in position. The 2-in. hot-air pipes must exten from side to side of the tank, and be brought out at th 2-in. hole, a piece of 2⅞-in. pipe, say 4 in. long, connecti the tank with the circulator. The T-piece is 2 in. diameter, and the top of the tank must be 19 in. squa with a ⅜-in. hole in the centre. The centre should be raised about ½ in., and a piece of ⅛-in. pipe soldered i beside the ⅜-in. pipe to allow the air to escape. The ⅛-in pipe must be brought flush with the top of the machin which prevents the water getting air-locked, and ensur perfect circulation. The top of the tank should be turne down ½ in. all round, and well soldered in as the lid of box. The 4-in. by ⅜-in. copper tube now projecti through the lid must also be tightly soldered; on

unt must the air-tube go inside the top of the tank, it must be soldered in the surface over a small hole e in the highest part in the centre. A sheet-brass d (Fig. 17) must be soldered on to the bottom of the k to hold the capsule. It should be ½ in. wide and rly ⅛ in. thick, a disk of tin being placed as shown to n a table for the capsule. A hole should be drilled the centre of the disk, through the frame, for the pin the capsule, and between the capsule and the disk



g. 18. — Diagram showing Dishing of Circulator

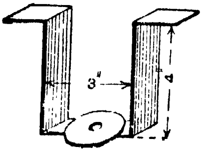


Fig. 17.—Capsule Stand

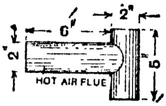


Fig. 19.—T-piece

uld be put a piece of stout asbestos or cloth, as the t conducted from the tank by the frame would cause capsule to expand before the required temperature, ely 104° F., was attained.

The circulator (H, Fig. 14) and the T-piece are made sheet copper; the bottom is dished as in Fig. 18, and -in. hole is left at the top to take the T-piece. The is either dome-shaped or coned, to allow the air to umulate, the tap being occasionally opened when the chine is started to allow any air or water to escape, when the water is heated it expands. A filling screw

is soldered in the top of the circulator, and the tank filled through it. The T-piece (Fig. 19) is 5 in. lo with a 6-in. projection, the hot-air flue being near top. A 2⅞-in. hole is cut in the side of the circulator the top of the T-piece is threaded through it. end of the T-piece is now soldered to the projecting e of the hot-air flue in the tank, and the top and botto of the T-piece are fixed in the top and bottom of th

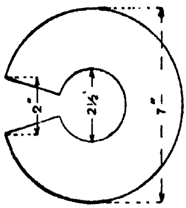


Fig. 20.—Pattern for Bottom of Circulator

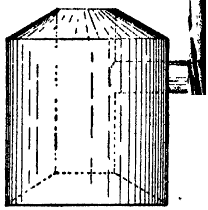


Fig. 21.—Cone-top Circulato

circulator, and the piece of pipe, 4 in. long by 2⅞ in. in diameter, is soldered over the 2⅞-in. hole in the side of the circulator.

A cone-top circulator is made of 5-lb. copper. The jacket is made of a piece of sheet copper 5 in. by 17 in. in the flat; this is bent into a circle and the two edges well lapped and soldered. Prior to bending it, cut a 2-in. hole 3 in. from the top edge; this hole is to pass the long end of the T-piece through. Now cut a disk of copper 7 in. in diameter with a 2½-in. hole in the centre; this disk must be dished. To obtain this shape it is necessar

› cut out a wedge piece 2 in. wide from the edge to the ›ntre (*see* Fig. 20). The two edges are now drawn ›gether, lapped, and soldered; the bottom is then ready › be soldered to the jacket, and the bottom of the T-piece ›ldered into the hole in the bottom. The top of the ›rculator is made in a similar manner, and of the same

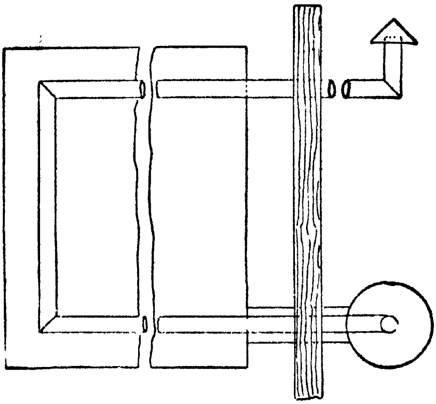


Fig. 22.—Plan of Hot-air Flue

›imensions. The air-tap is soldered in the top of the ›irculator close to the centre, and should be left open ›hen the tank is being filled, so as to prevent the water ›etting air-locked, which would prevent the water cir›ulating. The centre hole will be 2 in. when the disk › drawn together. Fig. 21 shows the circulator.

The hot-air flue is carried from the circulator across ›he front of the tank, then along the side, and returns

across the back of the machine through the side of the tank, packing, and outer case, and projects, say, ½ in., or it may be turned up with an elbow and cap, as shown in Fig. 22. The flue can be made of 5-lb. sheet copper, Fig. 22 showing where the mitred joints occur. These mitred pipes must be well soldered together, and should be tested with boiling water before the flues are fixed in the tank to ensure the joints being sound; a leak will often show with boiling water but not with cold water, owing to the metal expanding when subjected to heat. Four strips of wood, 2½ in. wide and ⅜ in. thick, should be placed on the top of the inner case, so that they reach the outer case. On them rests the packing round the edges of the tank. The tank is now placed on top of these pieces so that there is a 2-in. space all round the tank, and this space is filled tightly with silicate of cotton or powdered cork or sawdust, silicate of cotton being preferred. The top of the tank should also be covered with the same packing. The circulator is now soldered to the piece of projecting pipe, which is 4 in. by 2⅞ in. The 2-in. hot-air flue is also connected to the T-piece in the circulator, as in Fig. 23.

The regulator rod with the cap on the end is sufficiently long for the cap to hang over the top of the T-piece in the middle of the circulator, so that when the cap is down, it alters the course of the heat, and passes it through the air tubes. A ⅛-in. straight wire, sufficiently long to reach

to a screw in the regulating rod, is placed on the capsule, the screw being about ½ in. from the hinge of the rod and hollowed at the end by a centre punch or small drill. The wire from the capsule is filed to a point to prevent the screw slipping off it, as shown in Fig. 24.

The lamp is of tin-plate, with a ¾-in. Queen Anne burner fixed about 1 in. from the end. It should be 20 in. long, 4 in. wide, and 1½ in. deep, and its top is cut and lapped at the corners the same as the tank, and then soldered

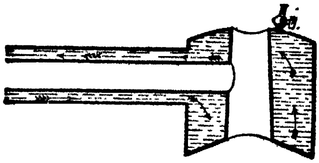


Fig. 23.—Joint of Hot-air Flue and T-piece

on a piece of flat tin 20¼ in. long and 4¼ in. wide, thus allowing ⅛ in. all round the lamp bottom for soldering. To show the quantity of oil in the lamp, a float is constructed of round cork 1¼ in. by ¼ in. thick. A thin wire is passed through the centre and is fixed in the cork by a piece of thin tin being soldered at the top and bottom of the cork. Place this in the lamp before putting the bottom on, and pass the wire through a small hole made in the top of the lamp about in the middle; this wire must work in a guide soldered on the lamp to prevent it tilting when rising. A gauge is soldered close to this wire to show the height to which the wire rises when the

lamp is full, and as the oil burns the wire will fall. T best guide is a piece of tube 1 in. long and ⅛ in. in diamete A small piece of metal is soldered on top of this tube wit a central hole, through which the wire passes easily. I fixing this float, get it upright, with the small holes in th lamp and pipe directly in line. The lamp is fixed o the side of the machine by means of a tin tray 4½ in. wid

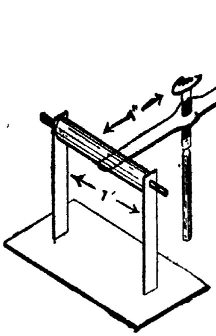


Fig. 24.—Regulator Rod, etc.

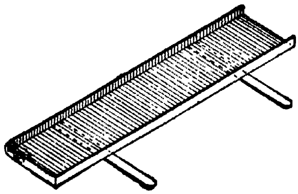


Fig. 25.—Lamp Tray

and 20½ in. long, turned up ½ in. at one end and be sides. It is soldered to two pieces of iron 7 in. long, in. wide, and ⅛ in. thick, and the ends of these stays slip in two square staples which are screwed on the botto the machine, so that it is easily removed (*see* Fig The chimney may be constructed of thin tin-plate wi a piece of mica or talc let in its side. When in its the top of the chimney is about ½ in. from the bo of the centre of the circulator. Into this space the a

shes, and gets heated, causing a very quick draught rough the hot air flues in the tank. A Queen Anne rner and collar can be obtained from any ironmonger's a cost of about 8d., and a reliable capsule can be obtained om the dealers. The thermometer should be 12 in. long, nd the section of it shows thus Δ which causes the ercury to appear nearly ⅛ in. wide.

The moisture tray is made of stout sheet zinc, say o. 11, and is 17 in. square, 1 in. deep, turned up 1 in. l round. This tray is half filled with equal quantities bulk of sand and broken charcoal, saturated with water, nd of course placed under the egg drawer on the bottom the machine. This should be examined once a week, d kept moist.

When the thermometer registers 102° F., the regulating rew in the damper rod should be screwed down so that e cap in the middle of the circulator is raised ⅛ in.

It is possible to bend copper pipe by first softening it, king it blood-red hot, and plunging it into water. It has to be filled with lead and hammered on a mandrel the required shape. This is a long process, and requires erience, as the lead then has to be again melted out . It is mitred with far less time and trouble, and result is quite satisfactory. Bending the pipe to required angle may slit it, and hammering it makes copper very hard.

CHAPTER IV

Making a 60-Egg Coil-heated Incubator

THE incubator illustrated in Figs. 26 and 27 is of a les usual type than those described in earlier chapters.

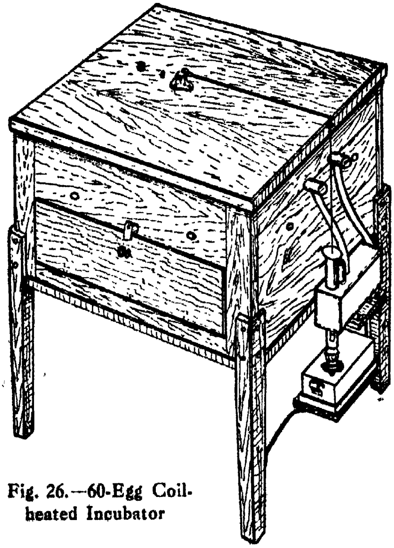


Fig. 26.—60-Egg Coil-heated Incubator

The [illegible]

a piece of [illegible] by a circulatory system of hot-water pipe the top of them a boiler fixed outside the incubator wall of the centre of that by this arrangement a more equa

mperature is maintained over the whole of the eggs
an by either the tank or the hot-air system, but, as
many related matters, this is a moot point. However,
markable results have been achieved by incubators
uilt on this principle. Their advocates claim that whereas

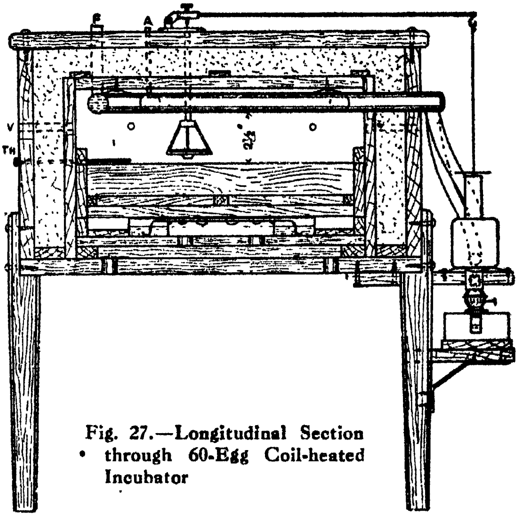


Fig. 27.—Longitudinal Section through 60-Egg Coil-heated Incubator

an ordinary tank machine the centre is always the
test part, and those annoying cold corners and sides
e well known, in the coil-heated incubator the pipes
e arranged round the sides in such a manner that the
ntre of the egg drawer is heated by side radiation only.
his arrangement tends to secure greater equality of
mperature.

Good, dry yellow pine is the best material for th woodwork. First make the drawer 1 ft. 3½ in. squar inside of ½-in. stuff 2¾ in. wide. Make it exactly squa outside, so that it may be taken right out and turn round side to front each time of turning the eggs, a so that any slight variations of temperature may hav no ill-effect. At a distance of 1¾ in. from the top, gaug

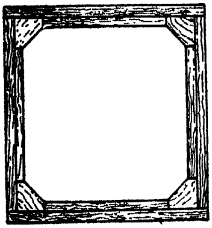


Fig. 28.—Egg Drawer Frame

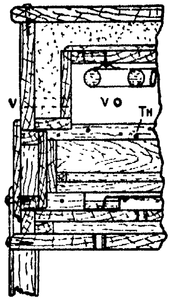


Fig. 29.—Part Cross Sect of Coil-heated Incubat

a line, and below it fix corner brackets 3 in. by 3 in. by ½ in., and ledges ½ in. by ½ in. all along between them as shown in Fig. 28. Then nail a piece of perforated sheet zinc on top of these for the drawer bottom.

Next frame up the inside walls, which are ½ in. thick and 10½ in. wide, for one side and the back, the right hand side being made 1⅝ in. narrower, so that the coil can be put in place later, a piece 1⅝ in. wide being used to make up to the full width. Make the inside width

e working fit for the drawer, and extend the sides 1 in. the front longer than the drawer, to allow for the door ckness. Nail a bar 1 ft. 4½ in. by 4 in. by ½ in. across ween the sides at the front level with the top edge, l a strip of equal length 2¼ in. by ½ in. at right angles n the first, as shown in Fig. 29. These serve to hold packing over the doorway. Seven and a half inches wn from the top, nail strips of about ½ in. by 1 in. section

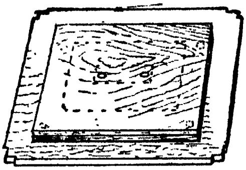


Fig. 30.—Outer Bottom

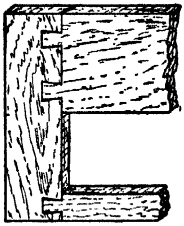


Fig. 31.—Egg Drawer Frame

on both sides to carry the egg drawer which runs on them, and nail two pieces above the drawer. Make the outer bottom of ¾-in. thick material and 1 ft. 11¾ in. wide by 1 ft. 10¾ in. deep from front to back. Cut away 1⅜-in. by ½ in. strips from both sides of each corner to take the legs, as shown in Fig. 30.

To the bottom, nail ledges 1 in. by ¾ in. thick all round ⅝ in. from the ledges, except at the front, where it comes 1⅝ in. of the edge. On these will rest the inner bottom to form the air space for ventilation. The inner bottom measures 1 ft. 5¼ in. by 1 ft. 4¼ in., and is [illegible] stuff

Bore four ventilation holes $\frac{1}{2}$ in. in diameter in the out bottom $5\frac{1}{2}$ in. from the edges for centres, and two throug the inner bottom centrally at 4-in. centres and of $\frac{1}{2}$ i diameter. Nail the inner bottom down on the ledg The inner walls should now be placed in position, a should fit outside the ledges, coming flush in front. N them to the ledges and up through the outer bottom, a fix distance pieces $1\frac{3}{4}$ in. by $\frac{1}{2}$ in. at the back and s flush with the front, to keep the outer walls correct spaced.

Frame up the front, dovetailing as shown in Fig. to leave the doorway matching the inside walls for widt about 1 ft. $4\frac{1}{2}$ in. and 5 in. wide. The *front* measur 1 ft. $10\frac{1}{2}$ in. wide by 1 ft. $\frac{1}{4}$ in. high, and should have a bottom bar of equal height with the inside bottom. Make the door of double thickness, leaving a space of $1\frac{1}{4}$ in. between, which can be packed with sawdust. The outer thickness must lap $\frac{1}{2}$ in. all round. Hinge the door at the bottom, and fix a button at the top, as shown in Fig. 26.

Make the outer side walls of $\frac{7}{8}$-in. stuff, 1 ft. $8\frac{5}{8}$ in. long by 1 ft. $\frac{1}{4}$ in. wide; but the right-hand side (the boiler side) should be jointed at the same height as the inner walls. The back should be made of equal width and 1 ft. 9 in. long. Well nail them together with the back piece inside the others; but leave out the top loose piece of the side, which should be secured with a coup of screws at each end later on when the coil has bee

lly tested and secured in place. Screw the front in place.

Now make the inside top 1 ft. $4\frac{1}{2}$ in. square by $\frac{1}{2}$ in., fix three ledges, $1\frac{3}{4}$ in. by $\frac{1}{2}$ in., to project $\frac{1}{2}$ in. each and in the positions shown in Figs. 27 and 29. When

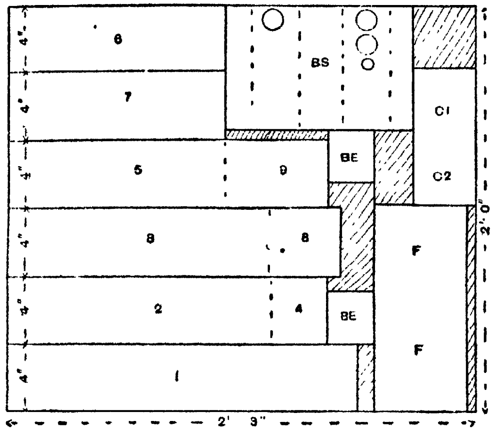


Fig. 32.—Laying out Copper Sheet for Boiler, Pipes, etc.

pped in its place inside the inner walls, the inside top rest on these ledges at the sides and ends.

Make the water tray 11 in. square by $1\frac{1}{4}$ in. deep, the tral ventilation space being 6 in. by 2 in., place in ition, and nail strips of $\frac{1}{4}$ in. stuff all round except the it, as shown in Fig. 27.

Procure a piece of 8-lb. sheet copper 2 ft. 3 in. by ., which will be sufficient to make the coil pipes and

boiler complete, and cut up as shown in Fig. 32. copper sheets are made 4 ft. by 2 ft. of various weig This particular gauge will therefore run 1 lb. to the squ foot, and should be bought for about 1s. per pound. No pipe (*see* Fig. 32) is made from a copper strip 1 ft. 8 i by 4 in. In Fig. 33 all the pipes will be found number off, and the pieces marked out in Fig. 32 correspond wi these numbers. Some of these pieces are long enough make two pipes, in which case a saving of material effected by cutting the resulting pipe in two on the mi which these lengths are calculated for. Bend the p plates one at a time round a broom handle or other simi rounded stick, tapping them into shape with a mal Clean the two adjacent edges, tie a piece of string ro each end to hold the bent plates to $1\frac{1}{4}$ in. diameter, th run the soldering fluid well into the joints, which shou now have about $\frac{1}{8}$-in. lap, and solder up, making thorough job of them, as, of course, they must be quit watertight.

Cut them on the mitre with a fine saw to the lengtl and positions of angles shown in Fig. 33. File the en until they will fit their respective partners to form corre right angles, clean up all round the joints inside and outsid and well solder as before described. As each corner finished, test it with hot water in the angle, filling pipes as full as possible, and rectifying any leakage be proceeding farther.

Put them together as finished on a level board (a ›d one is the inside cover, on which the coil may be out), so that the finished coil shall be on one plane. t a ⅜-in. hole for the filling pipe at mid-length in pipe . 2 before bending it, and drill a ¼-in. hole for the air ›e in pipe No. 6. When all the pipes are assembled and dered up, stop one end with a suitable copper cap,

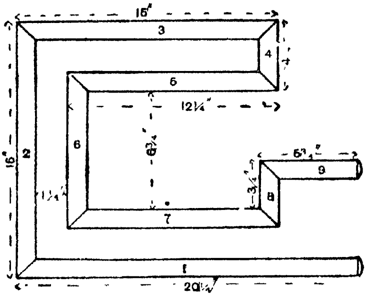
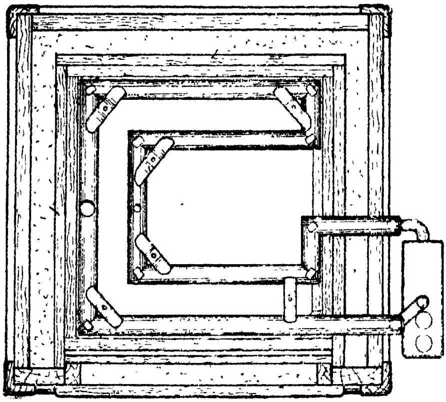


Fig. 33.—Circulating Coil

der the air and filling tubes in place (which are each in. long), plug them with wood, and fill the coil with ter at the open end. If any leak shows, resolder and t again until correct. Then solder a cap on the other d of the coil, and bore two ⅜-in. holes in the under side the coil as near as practicable to the ends. In these es the flow-and-return pipes from the boiler will afterrds be fixed.

Cut a number of small pieces of copper ¾ in. by ½ in. form strengthening gussets, and solder them across

the angles above and below, as shown in Fig. 34. Th will greatly assist the strength of the angles. Now c six strips of copper, zinc, tin-plate, or brass 3 in. by $\frac{7}{8}$ i and bend them to the shape shown in Fig. 35 to act hangers for the coil. They should hold it $\frac{1}{2}$ in. below th inside top. Drill a screw hole in each, and solder the



--Horizontal Section through Coil-heated Incubator

the coil angles as shown in Fig. 34. Give the whol coil, more especially the under surfaces, a good coat lampblack mixed with methylated spirit and just sufficie shellac to hold it together. Or mix turpentine and little gold-size or oak varnish with the lampblack. any case, it should dry a dead black, as this material assists the radiation of heat from the coil surfaces.

Lift off the inside top board, if the coil has not b

t on it, and screw the coil in its place, allowing ⅝-in. gin all round between the edges of the board and the es. Replace the board, and mark the position of the s to be cut in the inner and outer walls on the right-d side for the coil pipes to pass through. The bottom of the coil should now stand 2½ in. from the drawer edge, as shown in Fig. 27. Cut them out to fit, and frame is ready for the boiler.

Fig. 35.—Coil Hanger

Fig. 36.—Leg cut to fit Corner of Incubator

Meanwhile glue-joint the ⅞-in. boards for the outer er, which is of equal area with the outer bottom. Plane p, and bore the holes for the air and filling pipes of the l to pass through. Fit in place, and screw down h 1½-in. bottom or round-headed screws. Procure a ight incubator thermometer about 7 in. long, bore a through the left-hand side of the incubator on the l of the drawer top (*see* TH, Figs. 27 and 29), which be about the egg level, sufficiently large to allow a to be fixed across the two walls. It should be an fit for the thermometer, and also prevent the sawdust ing from choking the hole.

Bore two ½-in. holes in each of the four sides ri through the double walls for ventilation. They sho be about 1¼ in. down from the bottom of the coil to centres. Get a ⅜-in. round stick or tube 1 ft. long, a roll some glued paper round it to form a couple of pa tubes to fit the ventilation holes. When dried har these will cut up into eight ventilation tubes, which shou be glued across from wall to wall in the holes bore previously to receive them (*see* v, Fig. 27). Procure quantity of coarse dry sawdust, raise the outside to and tightly pack all the packing space with the dust.

The capsule regulator now requires attention. whole thing may be bought complete for a few shillin and this is really the best thing to do. But for those w wish to make their own, full instructions are given Chapter VI. In this machine the needle tube of t regulator from which the capsule bracket is suspende should be sufficiently long to hang ¾ in. below the coil and should be screwed or soldered securely to the bracke plate on top; there being no tank to secure it to, th support is necessary. Its bottom end is screwed to t the capsule bracket thread. Bore the necessary holes receive the regulator at about the position shown in Fig. and fix it in place.

Plane up four legs 2 in. square and 1 ft. 7 in. long, a from a point 7 in. down from the top, taper them to 1¼ square. Gauge off ⅝-in. thickness on two edges at

end, and cut away between them for 5 in. down (*see* 36), so that they may fit the incubator corners, and w them securely in place at the four corners.

The next part is the boiler. This type of horizontal er has been specially designed for this incubator. It been arranged to give a flue area as long and large possible. The whole thing is made of the same gauge per as the circulating pipes.

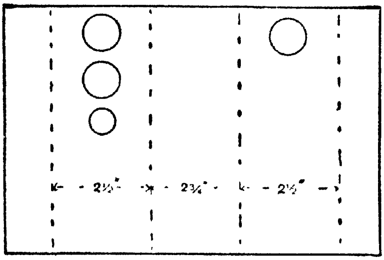


Fig. 37.—Plate Diagram for Boiler Shell

Cut out the plate for the shell 7¼ in. by 10¾ in., mark the three holes for the two chimneys 1⅛ in. in diameter, the exit water-pipe hole ¾ in. across. The 1⅛-in. hole ake the bottom of No. 1 chimney must also be cut. se should be spaced as indicated in Fig. 37. Plane block of soft wood 9 in. by 2¾ in. by 2½ in., and round off the corners. Bend the plate carefully round this the 7-in. side lengthwise, so that the lap seam shall be e of the sides and the holes central at the top; but ot now solder it. Next prepare the flues. Cut out

the copper for these in one length 12 in. by $5\frac{3}{4}$ in., l round a block of $1\frac{7}{8}$-in. by $\frac{3}{4}$-in. section, clean up w glasspaper or by scraping with a knife both surfaces of joint, and carefully solder up watertight.

Now mark off the lengths as shown in Fig. 38, and w a fine saw cut them across at a mitre angle of 45° whi still in position on the wood. File up the joints to together at right angles, and see that the two horizont

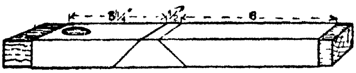


Fig. 38.—Cutting Boiler Flues

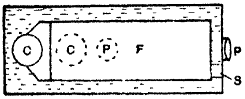


Fig. 40.—Horizontal Section through Boiler

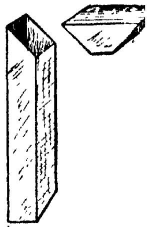


Fig. 39.—Mitre Jo of Flues

flues are parallel $\frac{1}{2}$ in. apart. The mitre joint is show at Fig. 39. Cut the $1\frac{1}{8}$-in. hole in the shorter top fl for the No. 2 chimney, and shape the corresponding en of the longer bottom flue to fit into the No. 1 chimne as shown at Figs. 40 and 41.

Make both chimneys in one 8-in. length out of a $3\frac{1}{2}$-i wide plate. Cut out the slot for the flue connection Fig. 42, also the $\frac{3}{16}$-in. square peep-hole for the la flame, roll round the broomstick, clean the edges, a solder watertight. Cut off a length of $2\frac{3}{8}$ in. for No

n the end without the hole, and carefully fit the opening No. 1 to the lower flue. Solder them tightly, and se up the two side gaps formed by cutting away the e tapered down in width to the chimney diameter

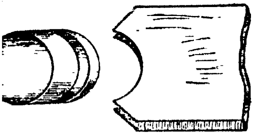


Fig. 41.—Joint of Chimney and Flue

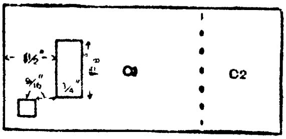
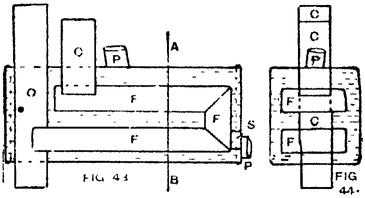


Fig. 42.—Plate for the Two Chimneys

bout 1⅛ in.). Small scraps of copper plate cut to fit d soldered in place do nicely. Next fit No. 2 chimney its place in the top flue. Clean the joint, and solder in position ¼ in. down in the flue, as shown in Figs. 43



Figs. 43 and 44.—Horizontal Section and Cross Section through Complete Boiler

44. This serves as a baffle to keep the flue full of air. Fit a piece of plate across the open flue end and ler. The letter references in Figs. 40, 43 and 44 agree. The flues and chimneys are now complete, and should carefully tested for watertightness. Then fix them

n the boiler shell, by spreading it partially open a coaxing them into their respective positions, and soldering them so that the spaces between the flues and shell at the bottom and top are respectively ¼ in. and ½ in. In Figs. 4 and 43, s is a short pipe ½ in. in diameter passing into the flue, which is corked when in use, and is intended as a sweephole should the lamp smoke at any time.

Two plates, 3 in. by 2¾ in., will be required for the boiler ends. In one of them cut a ¾-in. round hole ⅜ in. from the bottom edge centrally. Place them against the ends of the boiler shell, so that they project ⅛ in. all round, mark with a scriber, bend the edges down as a flange at right angles, so that they fit the shell, scrape the joint and solder. All the boiler joints should be carefully made, tested with water step by step, and also when finished. Should any difficulty be experienced in soldering the inside angles of the short flue, the space being rather small for an ordinary soldering bit, place some bits of solder in the corners, wet with fluid, and use a blowpipe on them, or the tapered square end of a worn kitchen poker made red-hot, as did the writer. Screw the boiler shelf, which is 5 in. wide, underneath the incubator to project 5 in.

Two strips of plate ⅞ in. wide should be cut for feet and drilled for ⅛-in. screws, bent as shown in Fig. 35, and soldered in position about 2¾ in. apart. Now screw the boiler to its shelf, leaving the chimney well clear as shown

ll is now ready to connect the boiler up with the so that it stands on its shelf 1¾ in. from the incubator and about 6¼ in. below, measuring from the bottom the coil to the boiler top. Use ordinary thin copper n. piping, bent to suit the positions as shown in Figs. 26 1 27, and solder the pipe from the boiler top to the front night pipe of the coil. This carries up the hot water circulation, while the pipe leading from the other end the coil to the boiler end r the bottom brings the urn current of cooler water k for reheating and recir-ation. Use plenty of solder strengthen the pipe connec ns. If screw union joints used at one or both ends the pipes, they are easily detachable for transit, but not needed for use.

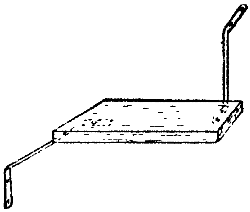


Fig. 45.—Method of Securing Lamp Shelf

A ¾-in. Silver chimneyless burner is required for the np, which measures 7 in. by 4 in. by 2 in., and should fitted with a handle as shown in Figs. 26 and 27. Its lf should be screwed ¾ in. lower than the lamp should nd, a packing block being provided of that thickness. method of securing this shelf by means of two ⅜-in. round brackets is shown in Figs. 26 and 45. When the p is lifted until the burner fits up against the chimney, block should just slide in place, and must, of course,

be removed when the lamp is taken away. The la flame may be easily seen for regulating through the sm square cut out of the chimney, and glazed with a sc of mica sheet $\frac{7}{8}$ in. square. The mica is held in positi by the four small strips (*see* Fig. 42), one on each si being cut free at each side and bent outwards. The mi is then placed in position, and the bent strips pressed ba in place; these hold it firmly. When the damper down on C_1, the heat passes into the flues to escape C_2. When the damper opens, the heat leaves at C_1, a so allows the water to cool.

Now place the capsule regulator rod in position o C_1 chimney, cut it to length, solder on a small hook suspending the damper, and cut a wire to the corr length for the damper to rest on C_1, not forgetting a lo in its top end, to be slipped over the regulator rod hoo as shown in Fig. 27.

Into the filling tube F (Fig. 27) place a funnel, and pro ceed to fill the coil and boiler with hot water, keeping a sharp look-out for any leaks. Should any appear, unscre the boiler feet and lift out the coil and boiler carefull for inspection. Mark the leaks with chalk, pour off th water, and thoroughly resolder the defective joint Replace the coil in position, screw down the boiler fe refill all with hot water, meanwhile tilting the incuba to and fro, so that all air shall be passed out at the a hole A (Fig. 27) and the filling hole.

When the water begins to rise in the filling tube, stop ing, fill the lamp with oil, and light up. The hot ent will soon be circulating through the pipes, and expansion as the heat increases, will probably over- · a little at the filling pipe. This must be watched a sponge or cloth kept handy for mopping; but a er way is to have a small syringe ready at hand, and this suck up a little as it threatens to overflow.

When the temperature is quite up, the tube F (Fig. 27) be kept nearly full, for this acts as a cistern to keep coil full of water, which is essential for free circulation. must not get into the pipes, and cannot while the pipe full of water. While in use, a little water must be ed occasionally, as it evaporates from the coil heat.

Increase the heat until the thermometer at the side sters 103° or thereabouts, then allow all to warm up a couple of hours. It will then be time to regulate machine. Open the draw door, place the capsule in stirrup, being careful that its bottom stud is passed its receiving hole. Pass the regulator needle down tube until it rests securely in its appointed depression he capsule top. Mark off at the top the correct length he needle, cut off with a file, and place the regulator over it. Turn down the regulator screw until it rests he needle, and continue until the damper begins to ff C_1 at 103°, by the thermometer below.

he correct hatching heat is about 104° on the eggs,

and the better to ensure this it is well to have an e thermometer to be used actually resting on the eggs. cheap clinical one is best, as it registers the maxim heat permanently until the mercury is shaken down aga This may be moved about to different parts of the dra while in use, and will show any variations of heat is also an effective check on the other thermometer an through its checking it may be found necessary to r the machine at a higher or lower temperature show the side thermometer, to ensure the correct 103° or 10 on the eggs. This point cannot be too strongly emphasi as machines are often run correctly to their thermomet but may be 2° or 4° colder on the eggs.

To prevent waste of heat from the boiler by radiati it should be covered with two thicknesses of loosely wo sacking, such as is used to make potato and onion sack This should be fitted tightly to the boiler, slitting t stuff where the chimneys, pipes, and feet project, pass the material round them, and sewing it all snug and t Cover the coil connection pipes also in the same manne In a teacup mix 2 parts of whiting to 1 part of Portlan cement, and add water while mixing until like thick crea Spoon it on to the sacking, rubbing well in with the finge and finishing it off smoothly all over. When dry t will form a hard, non-conducting covering, and will w repay the little extra trouble involved, by the saving oil required for heating.

Give the woodwork of the finished machine outside a t of shellac varnish, into which has been dissolved ficient bismarck brown to make it a rich, deep red de. When dry, give two further coats of the varnish thout stain.

In use, it is an easy matter entirely to pull out the g drawer during the process of turning the eggs, and closing the hinged door to retain the incubator's heat. is the eggs that require cooling, not the incubator. This nt is often overlooked. Its advocates claim that even the machine is cooled down, this form of incubator will rm up far more rapidly than any other hydro machine, cause of the comparatively small bulk of water. It l also be found very economical indeed for oil fuel.

When returning the drawer to the incubator, it is a od plan to turn it round, front to side, each time, in se the temperature of different parts varies a trifle. is is rendered easy by the drawer being made square r this purpose.

See that the water is always visible in the filling tube, ding a little occasionally as it evaporates, full pipes ing essential to a good circulation.

CHAPTER V

A New Design of Hot-air Incubator

THIS handbook would not be complete if it did not tre on the practical construction of a hot-air incubator. Th machine—the "Mezna"— here selected for description not of the customary hot-air type, but is a new and spe design, originated by Mr. Lionel Hall, a British ma and also an experienced poultry breeder, who has be particularly successful in artificial incubation for th "day-old chick" business. He is confident that a machi giving better results at the same cost and more easi managed is unobtainable at the present time.

This machine does away with the long winding flu pipe, which is so difficult to clean and the fouling of whi causes an increase in fuel consumption. Often the flame is raised dangerously high, this causing soot to deposit in the flue, and so makes matters worse. The machine here described and illustrated is not just an improvement along well-known lines, rather is it a distinct type by itself. Instead of the huge tank and intricate flues hot-water circulating tube is employed instead, the flam from a smaller lamp being ample to hatch large quantiti of eggs. There are no parts to get out of order, no inte

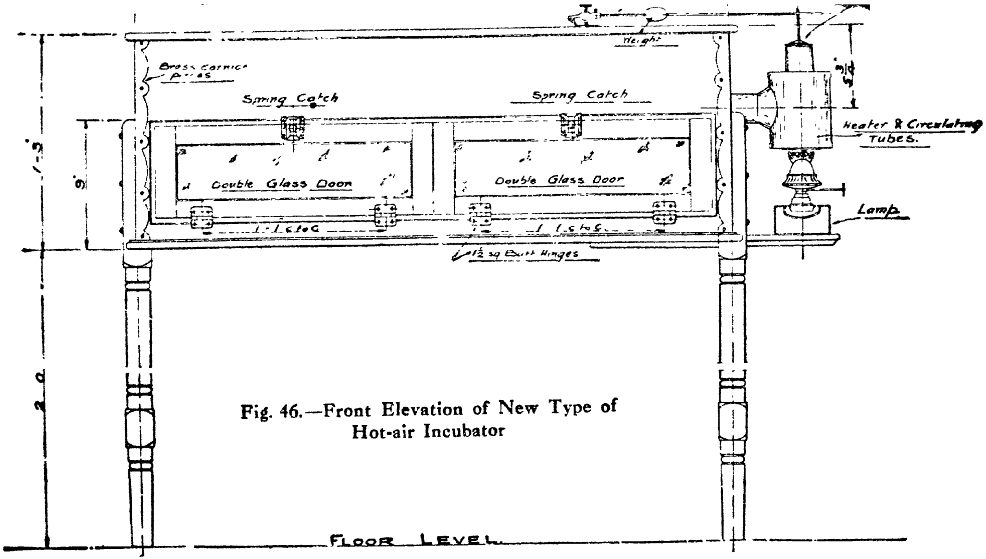


Fig. 46.—Front Elevation of New Type of Hot-air Incubator

construction that can get out of repair, and the h flue, and circulating tube are all in one piece, m everything less complicated. By this system two difficulties are overcome. The flue being only 6 in. l it is easily cleaned, and the temperature in cold weat is maintained satisfactorily. The inventor has prote this new system of heating, but readers of this handb are quite at liberty to construct the machine for use, not for sale. The inventor supplies all parts and fitti that cannot be made at home. Inquiries should be dressed to Lionel Hall, Causeway, Fishponds, Bristol.

The machine is very fully illustrated by Figs. 46 67, under each of which is an explanatory inscripti

The chief materials used will be $4\frac{1}{2}$-in. by $\frac{5}{8}$-in. V-sha matchboard, 3 in. by $\frac{3}{4}$-in. wood for the framework, millboard or strawboard for the inner case, flocks packing, the various fittings, and 6 lb. or 7 lb. sheet-cop for the heating tube.

Make the two ends of the incubator first, by constru from 3-in. by $\frac{3}{4}$-in. timber two frames 2 ft. 6 in. by 1 ft 3 i These frames, halved together, are covered with $\frac{5}{8}$-i matchboard, using panel pins as nails; they will dri easily, and the small heads can be punched in. Plane t frames square. By using narrow matching shrinkage w not be noticed; but if glue joints are made, or wide boa used, they so often crack or joints open. The nar V-matchboard will cost less, and always remain g

es, the difficulty of making a glue joint is avoided. ll the lengths (3 ft. 6 in.) of matchboard for the back. ove a groove or tongue, and plane square. Nail this

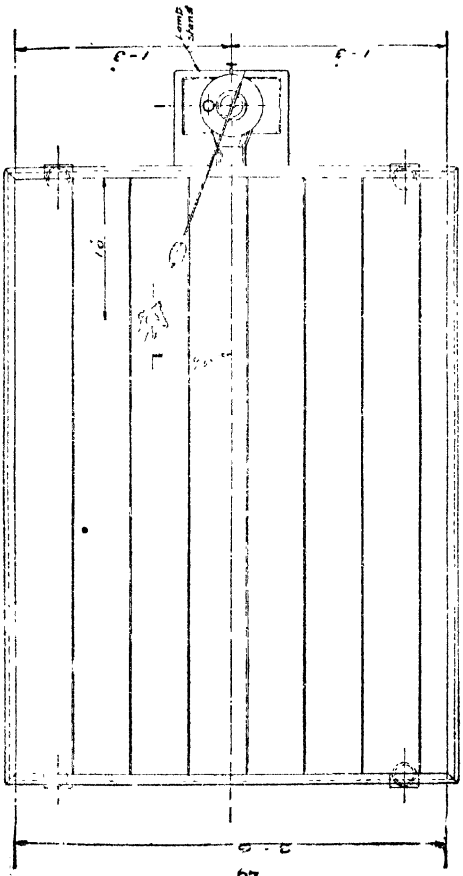


Fig. 47.—Plan of New Type of Hot-air Incubator

on to the two sides, and board up from the bottom. the work on its back, and nail a trued-up piece of by ½ in. on the top part of the front, and a strip 3 i ½ in. on the bottom of the front. There will be left an

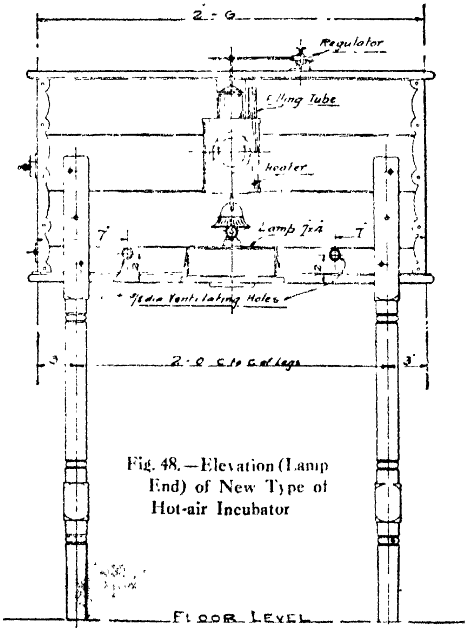


Fig. 48.—Elevation (Lamp End) of New Type of Hot-air Incubator

space of 6 in. along the front, which will be filled in later with the two doors. Lay the structure on the ground bottom up, and see it is quite square, then board over with ⅝-in. matchwood.

Make the two ⅞-in. ventilating holes, as seen in Fig.

ll be placed 7 in. from the front and 2 in. from the , and the other 7 in. from the back and 2 in. from ttom. Cut away a channel from the 3-in. by $\frac{3}{4}$-in. so as to give a free passage of air to enter the tor through the inner side.

the left-hand side, or opposite end of the machine

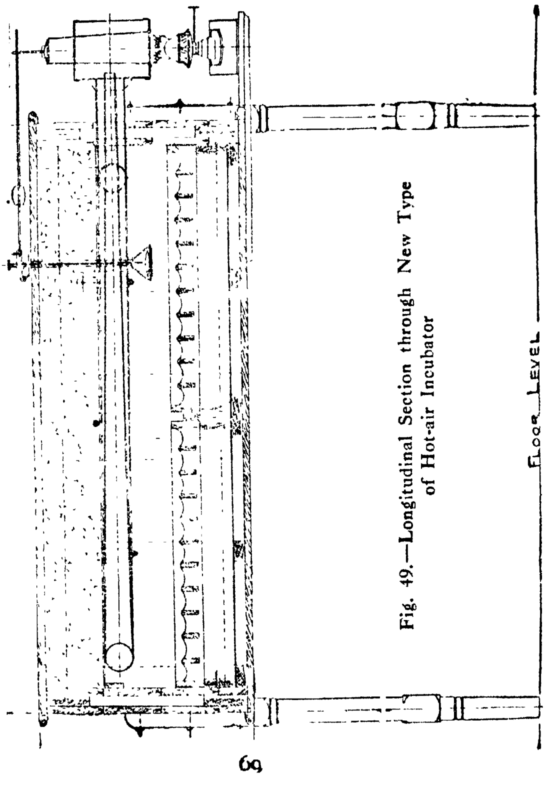


Fig. 49.—Longitudinal Section through New Type of Hot-air Incubator

put one hole 7 in. from the back and 7 in. off the bo and another 7 in. from the front and 7 in. off the bo

Next lay a strip of 3 in. by ¾ in. up the centre back, and nail a strip of the same material on the against the two sides, and along the top and bo This is to fix a piece of millboard on, thus giving a space between the two backs. Lasting tacks, or " ting as used in the boot trade, will be best to fix the millb on with.

With ⅝-in. matchwood cover the two inner sides f bottom to top, keeping the front edge flush with the ins of the front. Before nailing this in, the inner ventilat holes must be made. On the right or lamp side the ho will be 7 in. from the front and back and 6¼ in. from inside bottom. On the other or left side, the holes will 1 in. from the inner bottom and 7 in. from the back a front. When these holes are all made and the cham proved to be clear, nail in the sides.

It will be now observed that air enters at the la side of the machine, through holes 2 in. from the botto into the incubator at openings 7 in. from the front and ba and 6¼ in. off the bottom, across the heated chamb downwards, through two holes 1 in. off the bottom a 7 in. from back and front. (Reference to the illustratio will show what is meant.) These two holes will be ma through the runner of the egg drawer, into the air sp upward and outward through two holes in the outer

n the machine is complete, four circular plates, f pennies, can be made. A hole should be drilled each, close to the side. A small rose-headed vill fix this, as a revolving hinge, over each venti- that the plates can be moved to make the aperture e. To give more moisture during incubation, close

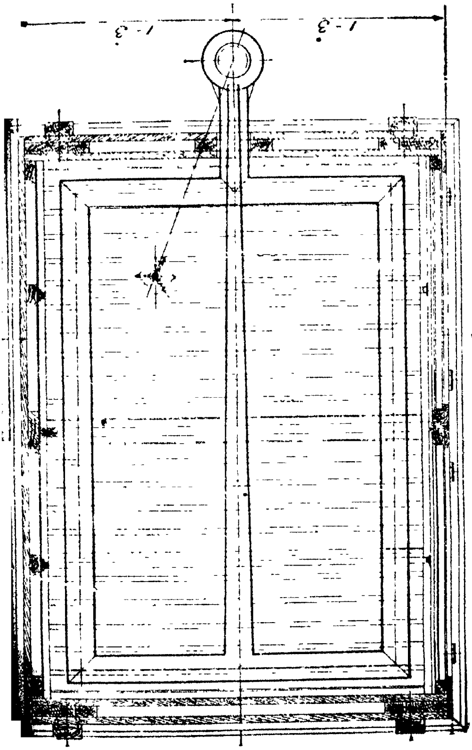


Fig. 50.—Horizontal Section through New Type of Hot-air Incubator

or partly close the ventilators. The best rule is, a
have the ventilators a quarter open, gradually incr
to full open by the nineteenth day, after which time
close them until the chicks are hatched.

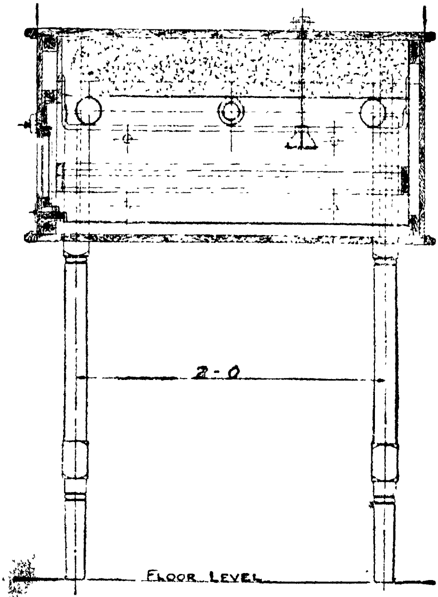


Fig. 51.—Cross Section through New Type of Hot-air Incubator

Nail a 3-in. by $\frac{3}{4}$-in. strip across the centre, from f
to back, on the bottom, and another each side on
bottom and front and back edges. This will allow
board to be tacked all over the bottom.

Procure four pieces of wood 2 in. by 1 in. to f

s for the egg trays. these up true. Nail ght-side one in its Put the two venti- holes in the left-side see that the air shaft r, and fix that in. Between wo other centre runners an t, the height of the front, is from 3 in. by ¾ in.; another ade for the back. The space een these two uprights carries a of 3 in. by ¾ in. Fix these five s of wood together by nailing ugh the runners into the other es. Place this exactly in the re of the incubator and perfectly ght. The front upright is first ned in with panel pins driven h the front; the back upright be nailed in from the back. long panel pins may be driven gh the bottom into this centre ure, which holds everything firm. o uprights can now be fixed to ont at each side to fill in the e of 6 in. from top to bottom, but

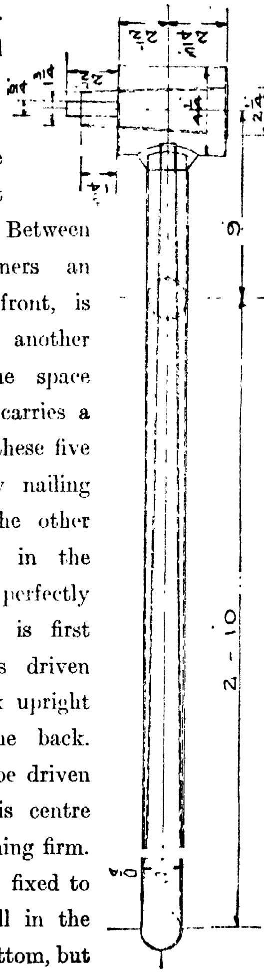


Fig. 52.—Side Elevation of Heater and Hot-water Tubes

not to come flush with the ⅝-in. inner sides. Allow ½ in. to form a rebate for the glass doors to fit a Nail a strip all round the inside front, and let ½ in. over for door rebate. Cover the front with mill allowing an air space as in all other parts of the ma It is this air space, or double casing, that keeps th chamber temperature even. One very thick wall not do it. The millboard or strawboard acts even l than wood. The double glass doors can be made of strips of wood 1¼ in. by 1½ in. Lay these down, fasten another smaller frame to them. Nailing with panel pins will make the doors very strong.

The construction of the woodwork has been simpl to assist readers who are not skilled woodworkers; sequently, stump mortice work for the door frames been avoided.

The two doors must fit the openings left for th An illustration (*see* Fig. 64) is given of a portion of double glass doors, and this will simplify everyth Lay one glass in its place; fix this in with a strip of w which forms a rebate to hold the other glass, to be secu with a few tacks and putty. Two 1½-in. butt hinges be required for each door. The doors must be faste securely and easily opened. This is best effected by spring catch, as shown in Fig. 46. The doors, now th are fitted, will be best left off until the machine is finish

The egg drawer or trays (*see* Figs. 66 and 67) will

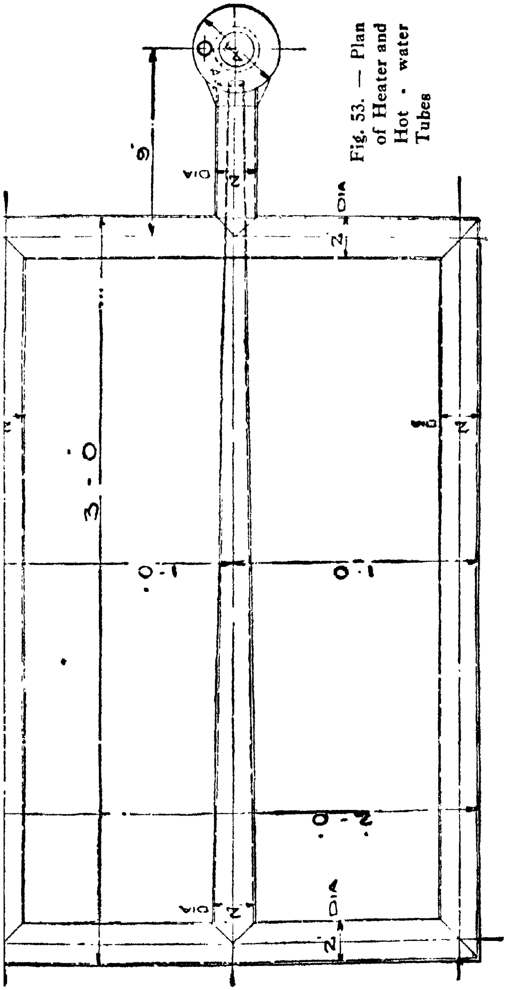


Fig. 53. — Plan of Heater and Hot - water Tubes

made from 2-in. by ½-in. stuff, free from knots. S
nail a frame together of 2 in. by ½ in. Into this,
1¼ in. apart, fix a 1¼-in. by ⅜-in. strip, with the top

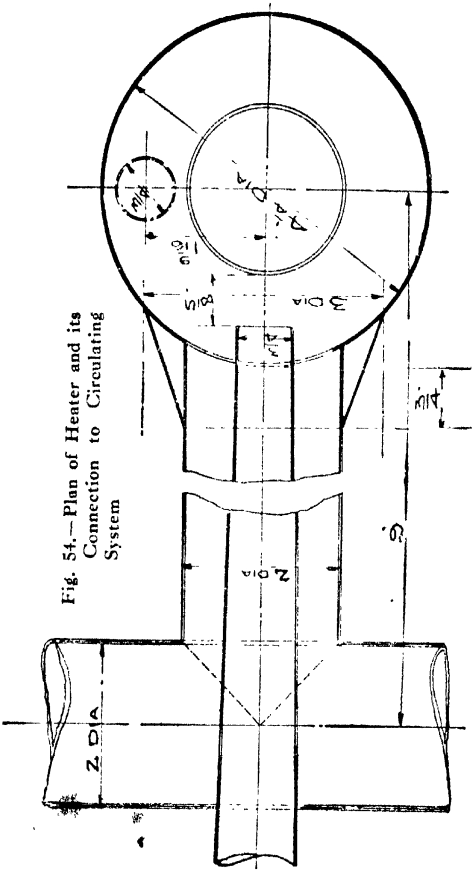
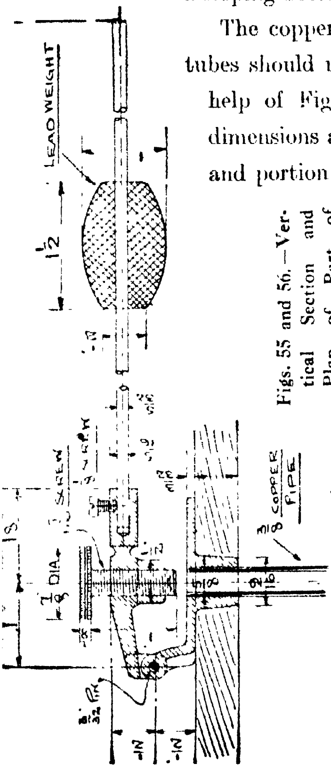


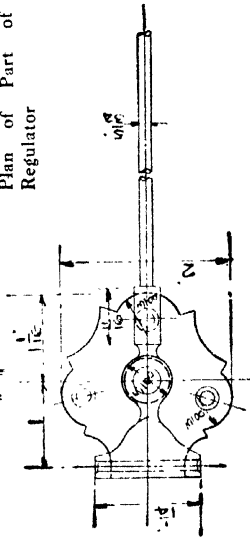
Fig. 54.—Plan of Heater and its Connection to Circulating System

ered off. Two panel pins will hold each strip firm. thin calico is tacked along each side of the egg drawer, ot the back and front; this is to sag down or droop e, as illustrated in Fig. 67. The eggs will rest firmly ese trays, and can be more easily handled than on a sloping bottom of perforated zinc.

The copper hot-water circulating tubes should now be made with the help of Figs. 52 to 54. All the dimensions are given. The heater and portion of the tube are shown



Figs. 55 and 56.—Vertical Section and Plan of Part of Regulator



in Fig. 54 to larger scale; 6-lb. or 7-lb. sheet cop is the most suitable metal. The heater is filled with ng by the filling pipe, as shown close to the flue. The causes the warmed water to flow through the 2-in. to the left and right of the smaller centre tube. P around, it meets again, entering the long central where it discharges into the heater. to be again heated distributed. This system gives a more even temper to all parts of the egg chamber, which is easily maint at small cost. The heater should always be kept water when in use, and any lost by evaporation m replaced by adding some warm water.

To fix the circulating tubes, cut an opening 2 through the centre of the right-hand side of the incub down to 7 in. from the inner bottom. The 2-in. connecting the heater with the circulating tube will in this groove.

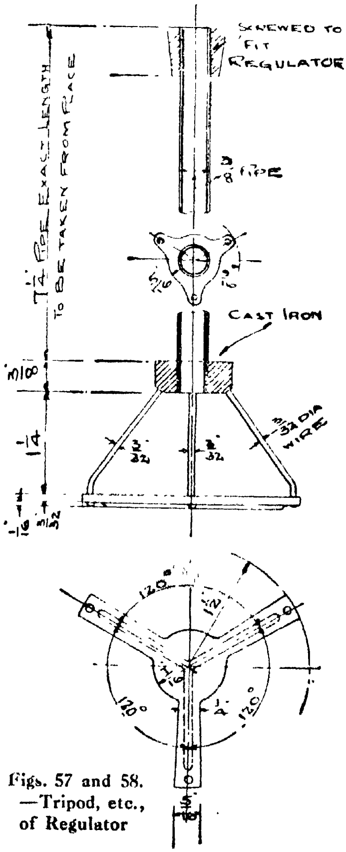
Out of ⅜-in. iron rod make two carriers the widt the machine, by flattening and bending up about 4 through the flattened part drill two holes for screws, will hold this carrier in position. The carrier hold heater tubes 7 in. from the bottom and quite level. F shows where the screws go and the method of fixin

Between the outer and inner case, just cut down, of wood can be nailed in to strengthen the side; an inside, at the top, can carry a strip nailed along, to bridge the opening and receive the pins when the top is fixed

piece of sheet metal is fixed round the top half of ube; and another piece, shaped to the bottom half, d with rose-headed screws to the incubator side.

ljust the heater ally, and fix with to the carrying rod. res can be fixed to s screwed into the ine. Lay a sheet rawboard all over heating pipes, and up to the top with s.

The lengths of $\frac{5}{8}$-in. chwood can now be off to form the top. ove the tongue or ve from one piece, fix this flush with front, and board until the worker s at the length of to carry the regu- Exact measure- s are given in 47. Through this a hole is placed



Figs. 57 and 58. —Tripod, etc., of Regulator

to allow a $\frac{3}{8}$-in. copper tube, $7\frac{1}{4}$ in. long, threaded ends, to pass into the egg chamber. The capsule ta tripod screws on the end in the egg chamber, ar brass regulator on the top at the other end Refere

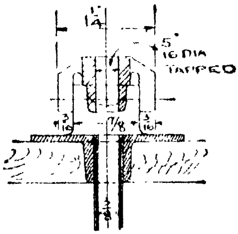
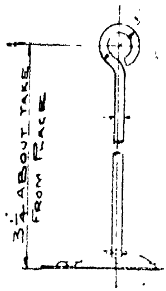


Fig. 59.—Cross Section of Regulator Parts at Right Angles to that shown in Fig. 55



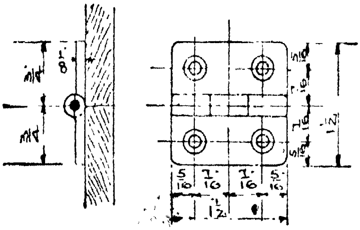
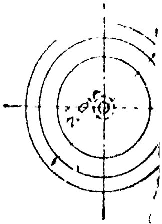


Fig. 60.—Butt Hinge



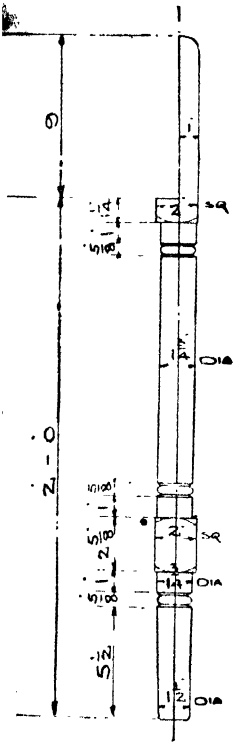
Figs. 61 and 6
Damper

Fig. 57 will show how it is fixed with three screws; it is not fixed until the last thing when the damper l over the flue.

The remaining part of the top should now be fixed and the edges of the top and bottom planed true. bead, easily procured at the timber yard, is mitred a

corners to fit round the top and bottom, to be fixed with 2-in. panel pins.

The incubator legs (*see* Fig. 63) can now be made out



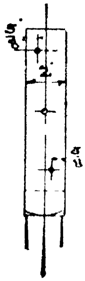


Fig. 63.—Two Elevations of One of the Four Legs

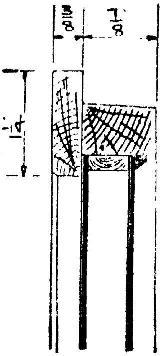


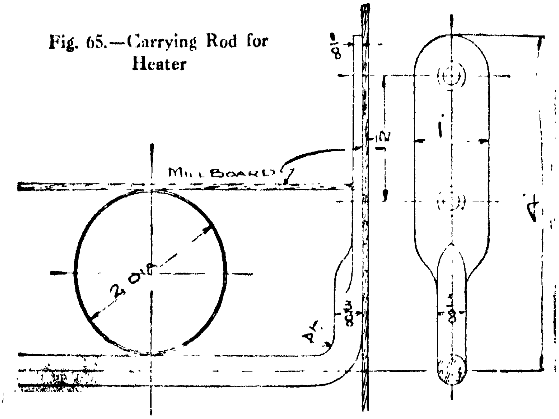
Fig. 64.—Part Section through Door

2-in. by 2-in. timber. Figs. 46 and 48 show how the F[illegible] rose-headed screws fix the leg. Reference to the b[illegible]elevation (Fig. 48) will show the legs fixed and where

the stop bead is cut away for the leg to take the weigh of the machine.

A lamp rest, as shown in Fig. 46, is made by nailing o: screwing a piece of wood to the bottom of the machine. having had the oblong-shaped piece of wood, like the lamp bottom, previously fixed to it. The lamp is

Fig. 65.—Carrying Rod for Heater



placed on this rest, so that the flame is exactly under the flue.

The lamp is made 7 in. by 4 in. by 2 in., as illustrated It is fitted with a chimneyless burner, which need not be placed too high into the short flue.

The capsule can now be placed in position, resting on the tripod, and a lifting needle fitted. Let it rest in the button on the top of the capsule, and stand $\frac{1}{4}$ in. above the

brass regulator plate. The end on the capsule is blunt; the upper end is pointed to fit into the socket of the regulator screw. Fit a brass rod from the regulator as shown, to reach a little beyond the flue, and construct a damper with hanger as shown in Figs. 61 and 62. A lead weight

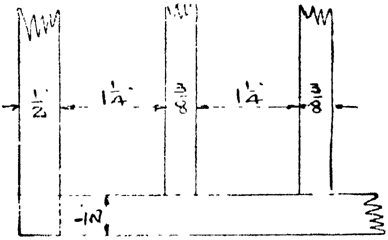


Fig. 66.—Plan of Egg Tray without Calico

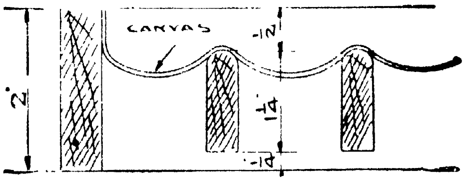


Fig. 67.—Section through Egg Tray

will be required to slide along the regulator rod. Reference to the sectional elevations (Figs. 49 and 55) will give the position of all the various fittings.

With the parts removed for convenience, the machine can be glasspapered smooth, stained, the nail holes puttied up, and the whole polished. An easy stain to make would be oak. Add brunswick or berlin black to turpentine

until the required strength is obtained. To get mahogany colour add some red. Apply with a brush. This being a spirit stain, it dries rapidly. A small quantity of polish can be made by dissolving 2 oz. of orange shellac in ½ pt. of methylated spirit. First rub the work over with thin coat of linseed oil, and then apply the polish. When this is hard, screw on the hinged windows, spring catches and the regulator. If wished, make four ornamental corner plates of thin sheet copper or brass, as shown in Figs. 46 and 48, and fix with small brass rose-headed screws. The finished incubator is now ready for use.

This is one of the very few hot-air machines in which the heat is supplied from hot water. With the usual type of hot-air incubators, if the lamp is left untrimmed, forgotten, or by accident the flame goes out, the eggs may be chilled. But in this case, should the lamp go out it would be many hours before the eggs became cold.

Incubators constructed on this principle have been in use by Mr. Hall for years. Actual practice has proved their advantages in the supply of very large quantities of day-old chicks.

CHAPTER VI

Heat Regulators

EAT regulators used in incubators depend for their tion upon the universally known fact that matter pands with increase of temperature, and contracts as e temperature decreases.

Briefly, if a box made of very thin metal is filled with id and sealed, its walls will bulge out or cave in accordly as the fluid expands or contracts with alterations temperature. It will be easily understood that by ans of a system of delicately poised levers, the bulging of the box may be made to open a damper and allow t to escape from a flue. This, then, is the principle the capsule regulator, by far the most generally used e. Next to this comes the J-tube regulator, in which, n, the expansion of a sensitive liquid is utilised; in case, it forces up a column of mercury, and the movet is transmitted by leverage, as before. Further, e is an all-metal regulator, which, while at first sight to objection, has given an excellent account of itself ertain well-known hot-air machines. Other regulators end on the expansion of gas (generally air), but they frequently of an experimental nature and there is

no need to consider them in this book. The capsu and the J-tube devices will answer all ordinary requir ments. The all-metal regulator is described on p. 133.

The whole action of a simple regulating system is easi understood by referring to Fig. 11, p. 28, which illustrat a customary arrangement of mechanism when employi a capsule regulator. With any rise in temperature aft a certain point has been reached, the top of a capsu will raise the rod A contained in tube B, transmit the mot to screw C, which is adjustable in the pivoted piece and thus raise a weighted lever E, from the other end which depends the damper F normally closing the G immediately over the lamp H. A $\frac{1}{16}$-in. rise of the verti rod A is so magnified by the leverage that the damper raised 1 in. The raising of the damper allows part of t hot gases to pass away direct instead of circulating throu the flues contained within the tank. As the temperatu of the incubator falls, the capsule slightly collapses a lever E falls, in this way replacing the damper. system is adjusted by turning screw C, thus raising lowering it, and by moving block J along the rod E, clamping it in position when desired by the set screw K.

The Capsule Regulator

This is a most reliable regulator if properly made and used; but it will not regulate every incubator without some adaptation to the peculiarities of construction. It

is designed for use in a hydro incubator, for which it eminently adapted. The amount of expansion which n be allowed in a capsule is but small, otherwise it would ckle and burst; but the expansive power is great, and has to be kept in check by mechanical pressure. Fig. 68 ows a common device. Inserted through the exact tre of the tank A, as shown, is a length of small tubing,

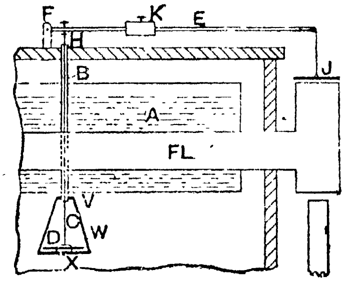


Fig. 68.—Capsule Regulator in Hydro Incubator

through which a rod, C, can freely work; this rod, resting the capsule D, will rise with its expansion. A lever, E, placed above the tank, having at one end a fulcrum, F, e behind the point where the rod touches, and the er terminating over the flue with a disk, J, attached to as a damper. It follows that, immediately the lifting C is forced upwards, the lever E will also be raised, this will be multiplied at the damper end, the increase pending upon the distance between the point of ntact of the lifting rod C and the damper disk J,

and also upon that between the contact point and th fulcrum F.

The capsule regulator consists of two thin plat joined together, forming a metal case or receptacle, her metically sealed, enclosing a small quantity of a volatil fluid, which, by the action of heat, is converted into vapour and occupies a much larger space than the fluid fro which it is generated, so distending or bulging out th capsule. On cooling, the vapour becomes liquefied, a the capsule returns to its former condition.

The boiling points of various fluids at ordinary pressu are as follow, the rise of boiling points being in inver ratio to the elasticity of the vapour of liquid :—

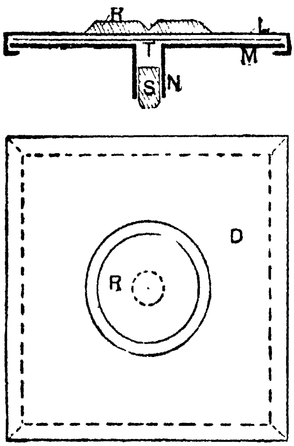
	Centigrade	*Fahrenheit*
Ether	35°	95°
Carbon bisulphide	47°	116°
Alcohol	78°	172°
Distilled water	100°	212°

With these varying boiling points, it is an easy matte to compound a liquid which shall boil at any require temperature, and, the boiling-point being dependent upo pressure, evidently that of any liquid placed within th capsule can be raised by simply sliding weight K alon the damper lever E (Fig. 68). What is required is a liquid which shall boil at somewhere about blood heat (98° F.) and this is found in a mixture of sulphuric ether and

cohol (spirit of wine). [*Note:* Water and ether will not ix.]

It does not matter, to a certain extent, of what material e capsule is made; brass is suitable, but the expansibility the liquid within will be in a measure governed by at of its receptacle. Size and shape also are matters small moment; it was usual to make the capsule of uare shape, 2 in. each way, but the circular shape is also pular. If the bottom plate is thicker than the top, it ll give greater stability to the finished appliance and ve an extra purpose by providing a firm base for a pin, ich, affixed to its centre, forms a means whereby it can kept securely in place in the incubator. The upper te L (Fig. 69) will require to be 2¼ in. square, of No. 33 ge, and the lower, M, 2 in. square, of No. 30 gauge .G. A disk, R, about ¾ in. diameter and as thick as a in, with a countersunk hole in its centre to form a g plate for the lifting rod C (Fig. 68) must be soldered trally upon the upper plate. This disk spreads the sure over the whole area of the capsule. In the centre he bottom plate the pin or stud is to be soldered, and comes in a detail of manufacture which will be found nvenience to those not very expert in soldering. The employed having to boil at about 98°, it is almost a ter of impossibility to make a sound joint to the capsule at the same time imprison the necessary liquid. Instead solid stud, a small piece of brass tubing, N (Fig. 69)

forms a convenience for filling the capsule; after th has been accomplished, a piece of brass rod, S, is inserte tightly fitting the tube and soldered in; a sound join can thus be made with the least trouble. Before beginnin to make the capsule, the sheets of metal forming it mus be made flat by beatin with a boxwood mallet so, if the would-be mak is not an expert in thi, he will be well advise to purchase the materi specially prepared.



Figs. 69 and 70. Section and Plan of Capsule

Having the plat flattened, the tube N place, and the disk R position, proceed to ben the edge of the lar and thinner plate ov the bottom of the thicke one, which will allow a turning of $\frac{1}{8}$ in. all round. Neatly solder this joint with a 2-in. square of blotting-paper, T, placed betwee the plates. Fill the tube N with sulphuric ether parts, methylated spirit 1 part; allow the liquid to soak in, adding as required until the blotting-paper will take up no more. Then pour off any surplus, and solder in the plug S, which, if carefully done, will make

capsule complete and ready for work. Fig. 69 is a somewhat exaggerated section of a capsule, and Fig. 70 a plan, the dotted lines showing the underside.

Next proceed to fix the capsule in position in the incubator. Taking first the hydro machine (*see* Fig. 68), the simplest method is to solder centrally through the tank A a length of small brass tubing, B, with the lower end threaded and projecting, say, $\frac{1}{4}$ in. through the tank bottom; a small brass washer, V, is tapped to fit the tube, and to this is soldered or riveted a couple of straps or bars of brass, W, bent to form a hanger, and joined at the base by a washer or disk of metal, X, having a central hole to accommodate the stud N (Fig. 69) on the base of the capsule, Fig. 71 shows this in detail. The lifting rod C will then pass through the tube B and rest in the countersunk hole in the disk of the capsule. The depth of this hanger must be regulated by the distance between the tank and the eggs; it should be deep enough to allow the capsule to rest within 2 in. of the tops of the eggs.

The damper, as already explained, needs a lever (see E, Fig. 68). It may be of, say, $\frac{3}{16}$-in. brass rod, or of ribbon brass, as shown in Fig. 72, fixed to a crosspiece of the same material, about 1 in. long, at its back end, and having at each end a small countersunk hole centrally punched or drilled. About 1 in. (or less) from the cross-piece the lever must be drilled and tapped and fitted with a small adjusting screw. To facilitate this, and also the fixing of it to the

cross-piece, the back end of the lever may be flattened hammering; and if a slot is filed in the cross-piece to acco modate the flattened end, the parts which will be in conta can be tinned and then soldered together by the aid of blowpipe. A bracket, F, to support the lever will be requisit and can be made of stout ribbon brass ⅜ in. wide and, sa 3 in. long, with the ends bent upward, ⊔-shape. Drill

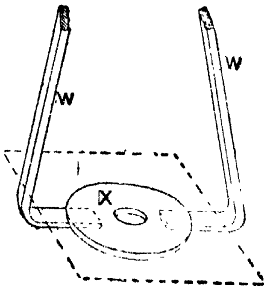


Fig. 71.—Capsule Holder

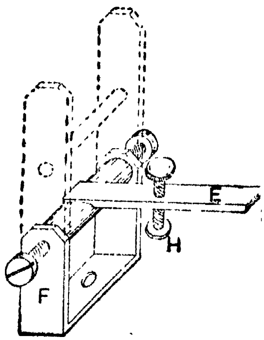


Fig. 72.—Fulcrum of Regulator Lever

hole in its base for fixing, and one in each limb. The limbs are to be tapped and fitted with sharp-pointed steel screws, as shown in Fig. 72. These points, engaging in the holes provided in the cross-piece fixed at the end of the lever, form the fulcrum on which it works. The adjusting screw H needs to have a small disk soldered or riveted to its point, in order to form a sure connection with the capsule through the lifting rod, which can now be

to length, so that it supports the lever in a horizontal tion.

The free end of the lever can be filed into a hook which a light rod or chain will support the per-plate J (Fig. 68); a weight, K, preferably with -screw, slides freely along the lever.

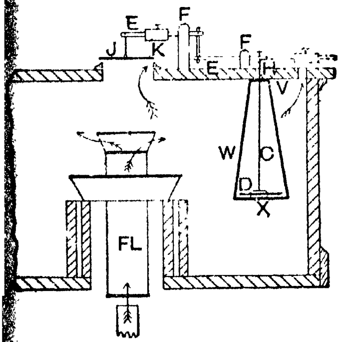


Fig. 73.—Capsule Regulator in Centrally-heated Hot-air Incubator

Fig. 74.—Brass Rod

In an old method of adapting the capsule to a air machine (as shown in Fig. 73), the hanging bracket t be 4 in. long. The upper disk V, instead of being ed and tapped as in Fig. 68, will require to have a bored centrally for the lifting rod C to pass through, three small screw holes by which to fasten it to the of the incubator. As will be seen by reference to . 73, there are two levers, E E, at different levels, supted on two brackets, F F, the levers being connected

by a strap of ribbon brass $\frac{1}{8}$ in. wide. The ends of leve if of rod brass, are slotted, as shown in Fig. 74, and fitt with pins, which also pass through the ends of the br connecting strap. In this the adjusting screw—the poi of contact—lies on the side of the fulcrum opposite that of Fig. 68. This lever can be lengthened to acco modate the sliding weight, as shown by dotted lines, the weight K can be mounted upon the upper lever shown in full lines. The bracket for the upper lever w need to be somewh taller than that for t lower, shown by dott lines in Fig. 72, which it is drawn stay by a cross-bar to preve the limbs being forced apart by the screwing-up of th fulcrum screws.

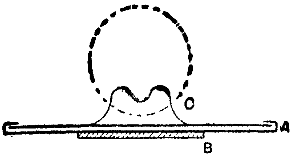


Fig. 75.—Modified Capsule

The above are substantially the arrangements c monly in use when the capsule regulator is employed. the hingeing and adjustment of the damper lever frequently accomplished in other ways; see, for exam Figs. 11 and 27.

A Modified Capsule.—Fig. 75 shows a capsule of th sheet brass, both sides being of the same thickness. leather disk, B, is glued on the bottom, and on the top soldered one of the copper disks, C, found in shot cartridges this has two holes in it. Before soldering the top an

tom together, make a small hole in one corner, and a thread through the holes in the copper disk. The sule is filled by holding the corner having the hole he spirit and pulling the thread in and out. Sufficient it is sucked in by this means, and the hole is stopped stantaneously with a drop of solder.

The "Acme" Regulator. —In a later chapter describing number of the incubators on the market will be found strations of two or three special regulator arrangements;

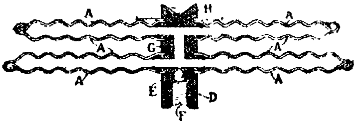


Fig. 76. —"Acme" Capsule

space must be found here for particulars of the Acme psule ("compound wafer thermostat") used in the Peerless" incubator made by the H. M. Sheer Company, Quincy. Illinois, U.S.A. It consists (*see* Fig. 76) of four rugated disks, A, of a bronze-like alloy so joined together t they form two chambers for the volatile fluid, upon expansion and contraction of which the working pends. The cup-shank H, the hollow stem G, and the er stem or valve shank D are riveted and soldered in sition, and through the stem there is inserted into the hambers a measured quantity of the volatile fluid. Then, the position illustrated, the capsule is placed in a warm

bath; the fluid does not escape through the opening beca its density is so much less than that of water. As the h converts part of the fluid to gas, any air is forced out throu

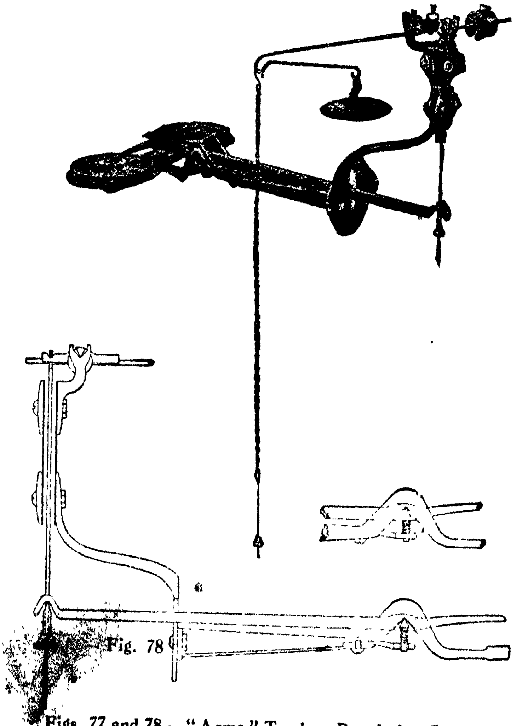


Fig. 78

Figs. 77 and 78.—"Acme" Tandem Regulating System

the opening, and when this process is complete the valve E automatically closes the opening; afterwards, the insertion of the screwed plug F ensures the permanency of the seal.

any patterns of Peerless incubators, this capsule is tandem fashion, as illustrated in Figs. 77 and 78. is arrangement, every lever has for fulcrum a knife- and thus, by reducing friction to a minimum, the is made as sensitive as possible.

e J-tube Regulator.—This is far more sensitive any other regulator in use, but it has its disadvantages. s to be so poised that the weight of a pin will shut pen it; and should the bearings get clogged, the will force the mercury in the tube beyond the cork , and not lift the damper. It is quite inexpensive, can easily be constructed. A glass tube A (*see* Fig. 79), uring 7 in. by ½ in., and sealed at one end, is turned d so as to form the letter J. The sealed end should urned up about 2 in. Ether, being a spirit, which at about 95° F., is the best agent to move the mercury, it should be poured into the tube until it occupies of the sealed end. Now pour in mercury until it hes within about 1½ in. of the open end of the tube. ether will now be found to have left the sealed end e tube. To get the ether back into position, place inger on the open end, turn the tube upside down, incline the tube so that the ether returns to the sealed where it must always remain. A piece of cork B, ch must fit the glass tube quite loosely, is fastened the end of a piece of No. 18 wire, C, about 4 in. long. cork is now passed into the tube and allowed to rest

on the mercury, the wire standing 2 in. above the This tube is placed perfectly upright in a wooden (indicated by dotted lines in the illustration), withe top, on the side of the incubator as close down to eggs as the drawing in and out of the drawer will pe. If convenient, the wooden case should be fixed in centre of the incubator, from which point most hea

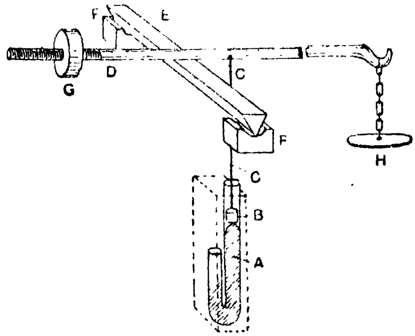


Fig. 79. -J-tube Regulator

derived, especially if the incubator is made with s n instead of double walls. The damper rod D is balan on a V-shaped piece of iron or steel E, the sharp ed of the V resting on two pieces of concave agate stone (procurable from weighing-machine makers). These sto are let into the incubator top, and secured with a glutin substance (seccotine, marine glue, etc., would answer. The damper rod D consists of a piece of ¼-in. round iron wire; a stair rod would be suitable. A thread

or 4 in. long is cut on one end of the damper rod, a lead weight G screwed on to balance the damper H, which covers the lamp chimney. The V-shaped ng is soldered to the rod and at right angles with the rod must cross the centre of the bearing. A centre-punch mark is made in the damper rod for point of the regulating rod C to rest in. The centre-ch mark must be ½ in. from the fulcrum, so that when mercury rises even $\frac{1}{16}$ in., the damper cap on the end the rod will be lifted more than half an inch; but less this damper rod is balanced by the screw weight, will fail to lift the cap, and the mercury will rise over cork, by the expansion of the ether in the sealed end the tube, at a heat of 104° F.

Automatic Gas Regulator.– Most of the automatic regulators for incubator work now on the market are tented articles, but the arrangement shown by Fig. 80 y freely be made by anybody. Assume the presence say a capsule system with the usual damper rod S . 80). At the back of the rod, behind the pivot, a hole to take the rod R, ⅛ in. or more thick, and 6 in. 8 in. long (*see also* Fig. 81), which should be strongly dered in place. On its extreme end, solder at right angles pin and a corresponding pin on the end of the lever a gas cock. Connecting the pins must be a brass strap C. lder the whole elbow to a small brass base or foot similar F (Fig. 81). The two pins should be lightly riveted

over to secure C from slipping off while allowing a fr
turning movement. When the correct positions ha
been found, screw the elbow in place by its foot, an
connect up the flexible pipes shown in Fig. 80 to the in
and outlet ends, leading the latter to the burner. As th
capsule expands and lifts the damper arms, it depress
R and turns round the cock lowering the gas. A rever

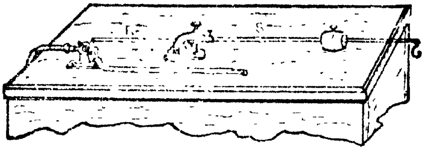


Fig. 80. Automatic Gas Regulator

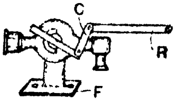


Fig. 81.—Gas Cock

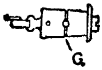


Fig. 82.—Plug of Gas Cock

movement turns up the gas. It is necessary to find by experiment the exact cut-off position of the cock before making the connection strap C, and to arrange it in such a way that the slightest movement lowers the gas. To prevent the gas being turned entirely out, file a tiny V-shaped groove G (Fig. 82) all round the plug in line with the bore hole; this will always allow some gas to pass.

As some readers may prefer a valve regulator to the arrangement above described, one is here shown (see

83). The body B may be a short length of $1\frac{3}{4}$-in. tubing, in which is soldered gastight a partition, P, ng a seating bored to fit the valve shown, which is d in one with its spindle, V S. A bottom is soldered e body, to which is secured centrally a short tube y fitting the spindle, and having a short weak spiral g, S, underneath the spindle. In the cover is arranged all, internally threaded stuffing box, to which the

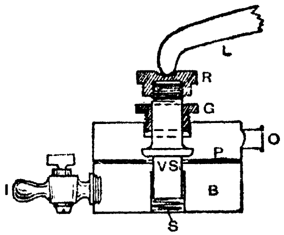


Fig. 83.—Valve Regulator for Use with Gas

d G is fitted. Tallow or other suitable packing keeps spindle gastight, while allowing free vertical movet. A lever, L, fitted to the back of an ordinary capsule lator arm, on the principle explained in the preceding graph, is bent to bear on the adjustable cap, R, which be screwed up or down to a suitable height. The e may be normally open $\frac{1}{16}$ in. or less, and when the ule expands through overheating, the lever L is forced n and shuts the valve. On the lever rising again, the ing S pushes the valve open. The valve may be about . in diameter, and may have one or more small V-

notches carefully filed in its beat to allow some lit gas to pass when the valve is shut, thus preventing light going entirely out. An inlet cock I and an out at O are shown, to which rubber pipes are to be attach Two or three lugs may be formed in one with the bott plate to project beyond the body, each drilled to take wood screw, and used to secure the whole in its corr position.

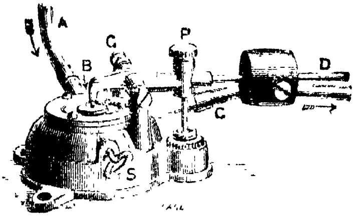


Fig. 84.- Excelsior Gas Valve

The Excelsior gas valve, obtainable for about sev shillings, has points of similarity with the above. By use the ordinary damper arrangement is obviated. The damper lever D (see Fig. 84) is continued to B, where operates the valve. A is the gas inlet, and C the outlet G is the pivot, P the adjustment screw, and S the by pass control.

It is not essential to provide a regulator or control when gas is the source of heat, any more than it is whe an oil lamp is used; but if, of course, means of saving gas when the internal temperature of the machine rises

opted, it conduces to economy in working. When fittings are ordered with the Hearson incubator, rrangement shown in Fig. 85 is supplied, and this rs satisfactorily where the gas pressure remains even. In many places, however, the pressure ; in thousands of houses, for example, the meter too small to all the s, and when capacity is eeded the ning on or of gas at one fitting cause the lights to or jump. ing a larger r, it is advisable in all such cases to employ vernor on the incubator fitting which automatically nts a sudden access of surplus gas when the house are turned down. Fig. 86 shows the Hearson governor, and by means of this device the supply be adjusted to a nicety, and the flame remains con- t in size.

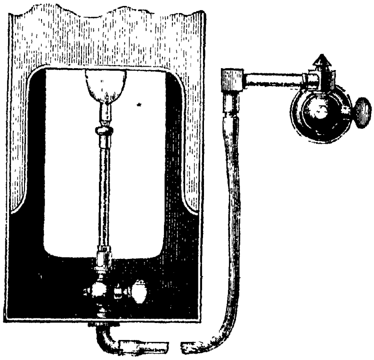


Fig. 85. Hearson's Gas Attachment without Governor

Regulating Incubator Heated from Separate Hot-er Apparatus.—It is practicable to supply an incubator

from a separate hot-water apparatus, but the regu must be worked on a ventilating shaft. The mecha is precisely the same as that used to control the obtained from a side lamp. The damper works ovei top of the shaft, and when raised by the capsule al heat to escape. By forming the shaft as shown in Fig direct draugl avoided. A tap may be serted in flow-pi between the cubator and the l water apparatus, so t the quantity of l water may be regulat The water in the ta should be at 10 The heat of the w in the supply apparatus depends on the distance has to travel before it enters the incubator tank, a unless the flow-pipe is insulated by covering with sl wool, hair felt, brown paper, etc., it will lose mu heat.

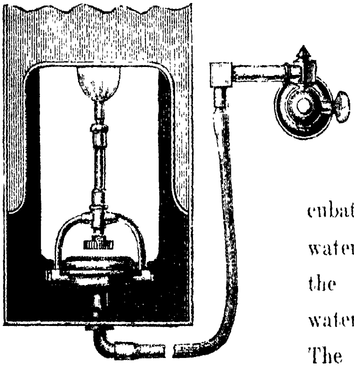


Fig. 86.—Hearson's Gas Attachment with Governor

Electric Alarm for Incubator.—Electricity has no been applied in any serious way to the solving of incubator problems. Electrical regulators, for example, are by

eans out of the question, but it is doubtful whether would have any real advantage over the present nical arrangements. On the other hand, indicators larms may be advantageously worked by electrical , as it is a simple matter to cause the indication

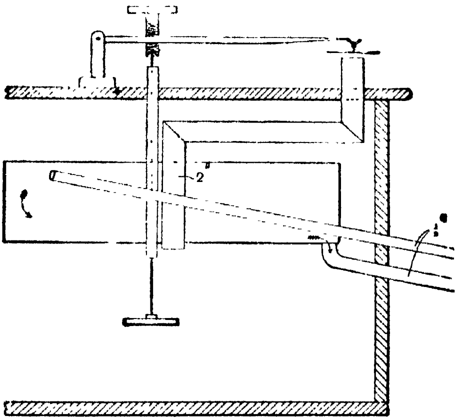


Fig. 87. Regulating Incubator Heated from Outside Source

gh or low temperature to be given in a place far ved from the incubator house.

he most effective electric alarm to indicate high low temperatures is the gardener's greenhouse electric mometer, which is made and sold by all manufacturing tricians. It is similar to an ordinary mercurial ther-meter, but it has in its tube two platinum wires, which connected to two terminals in circuit with an electric

bell. The tips of these wires can be moved in the tul and adjusted to any temperature. Should the merc rise too high or sink too low, the electric bell rings. having two bells of different tones, one on the high a one on the low temperature circuit, the owner can kn at once what the trouble is. Another effective ala may be made with an adaptation of a fire alarm, as sho in Fig. 88. Procure two very thin strips of copper a zinc, of equal thickness, from ¼ in. to ½ in. wide, a

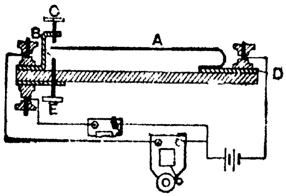


Fig. 88.—Electric Alarm for Incubator

from 3 in. to 4 in. long (A). Coat one side of the cop and one side of the zinc with solder, and sweat th together, that is, heat them in a Bunsen burner or a hot iron until the solder flows; then drill three or fo small holes at nearly equal distances apart through t strips, and rivet them with brass rivets. Bend one e as shown, and solder this to a strip of brass, D, ⅜ in. wi 1 in. long, and ⅛ in. thick. Fix this with short br screws to one end of an ebonite block 1 in. wide, ¾ thick, and 4 in. or 5 in. long. To the other end of t block fix a brass bracket, B, carrying an adjusting screw

on the opposite side fix another piece of brass, with imilar adjusting screw, E, passing through the ebonite ck. The tips of these screws will come in contact h the tip of the strip A, and connect one of the bell uits. When the temperature is too high, the zinc will expand fastest, and bend the strip until it comes ontact with one of the screws. When the temperature rs, the zinc will contract, and bend the strip in the r direction. Adjusting the screws to the highest lowest allowable temperature by the aid of a thermeter, the strip should be midway between the two n the temperature is 103° F. The connections of alarm with battery and bell are shown in the illustion.

CHAPTER VII

Successful Incubator Management

THERE are many incubators on the market. Some suppl heat from a tank, filled with water, above the egg chambe the other kinds give heat from hot air. Opinion is ofte divided as to which is the better type of machine. I Great Britain the tank machine is used most, but i America the hot-air type is usually employed. F private use or small establishments, the tank is of mos service; but for very extensive breeding farms, th largest size hot-air incubators are considered essential.

In selecting a machine, have the best that can b afforded, and, if it is bought complete, see that it bea a trade mark. The manufacturer who has protect his wares has both his capital and reputation at stak Any of the machines described in earlier chapters may b regarded as thoroughly reliable.

A really reliable incubator requires very little att tion. Simply trim the wick, fill the container with and turn the eggs over twice a day; the whole rout should not occupy more than twenty minutes. Th work and management of a machine is simplicity itse The best sizes to use are the 50- and the 100-egg siz

near). The smaller ones are with difficulty main- ...ed at a regular temperature, and cost more in pro- ...ion to size. Much larger machines are best adapted ... the very extensive breeding establishments.

For successful hatches, the eggs should be as near possible of the same age. For this reason alone only large breeders can fill up even one incubator of ... or, say, 800-egg capacity in the most satisfactory ...y.

Position.—Place the incubator where it is to be worked; ...oom facing north or free from the sun's rays. A cellar ... other cool place free from draught is best; never an ... house, where there are great variations of temperature. ... that it stands level and is firm.

Filling Tank.—Fill the tank with very hot water by ... filling tube on top of the machine.

The Lamp.—Fill the lamp with oil. If a "Silver" chimneyless burner, cut the wick straight across (not ... shaped), and allow it to burn a few minutes to obtain ... good flame. When burning and trimmed correctly, ...ce it under the flue.

Regulator.—Put the capsule in its place in the centre ... the hanger, and slide the lifting needle down the centre ...e on top of the machine, so that it rests on the button ... the centre of the capsule. The upper end is placed in ... socket of the regulating screw. Place the weight as ... as it will go to the left. Turn the regulating screw,

and see that it works freely, the damper hanging direct over the chimney where the lamp is burning.

Moisture.—Put the canvas in the water tray, and the eggs are not new laid, half fill with warm water, a place it in the centre of the egg chamber. The apertu in the zinc tray bottom should rest over the hole in t floor. If the eggs are new laid, put no water for abo the first fourteen days. See that the water is replenish when required and the canvas kept clean. Next sprea the canvas in the egg drawer.

Thermometer.—Put the thermometer in its positi in the egg drawer front, and always keep it there. should be drawn out far enough to see the thread of mercu when reading the temperature.

Initial Regulation.—With the egg drawer in, leave t machine. In some ten hours, according to the weath and season, the incubator can be regulated by movi the screw and weight, so that the thermometer regist the temperature at which it is proposed to work; 103 with the thermometer not quite touching the eggs, w give the best results. When the adjustment has be completed, the heat in the egg drawer will remain consta Regulated properly, the damper should be lifted off th chimney at 102°. Endeavour that the heat in the g chamber never exceeds 104°.

Eggs.—Eggs marked with an X on one side and on the other are placed on the canvas in the egg drawe

turned over twice daily. It is better to fill the drawer eggs than merely to half fill it.

ooling.—The eggs must be cooled when turning n. Experience will soon enable this to be done. the first week the operation of cooling is enough, by ime it takes to turn the eggs. Allow a little longer ext week, and increase the time until the eggs hatch. guide, first week five minutes, second week ten minutes, third week fifteen minutes. See that the heat (103°) he egg chamber returns in an hour, not in twenty utes one day, and at another time, in two hours; each time the eggs are turned have the heat back an hour. This will produce, invariably, splendid hes.

ariation of Temperature.—A little variation of temture, above or below that fixed on, will not affect general results; but if a rise or fall lasts more than days the weight should be moved to correct it. When gg drawer is taken out, the damper should automatically on the chimney in a few minutes. The regulating w should on no account be turned when the egg wer is in its place and with the heat at 103°, or the ng power of the swollen capsule may be impaired. ays open the drawer a little before altering the regulator, do so when turning the eggs. To make great alterations the temperature, move the regulating screw. For ll adjustments, slide the weight towards the lamp.

The weight should not be more than halfway acros rod. Remember that the nearer the weight to the the more sensitive the capsule.

Evaporation.—Evaporation of water in the ta not very great; but see that the tank is kept full,

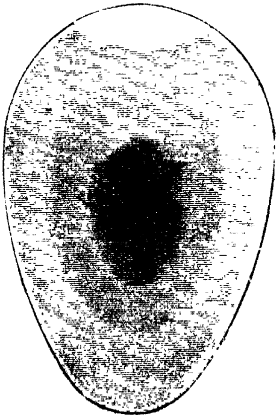


Fig. 89.—Fertile Egg after 7 days

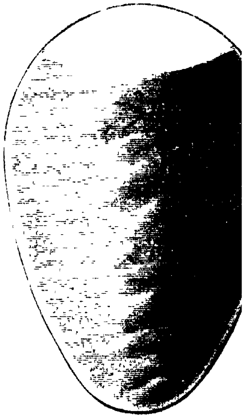


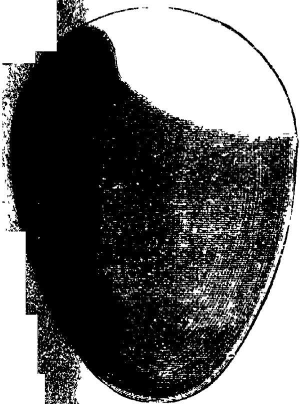
Fig. 90.—Fertile Egg after 13 Days

difficulty will be experienced in maintaining the te perature of the egg chamber.

Examining Eggs.—In a week the eggs should be amined before a light. Those that look dark are fert and should be put back in the egg drawer. The that are clear and look like new-laid eggs are not fert and should be removed. The appearance of a fert egg after a week is indicated in Fig. 89; after thirt

in Fig. 90; and at twenty days, in Fig. 91; an egg—a fertile egg in which the germ has died—in 2.

ods of Incubation.—The periods of incubation are . eggs 42 days, swan eggs 42 days, goose eggs 30 days,



91.—Fertile Egg at 20 days

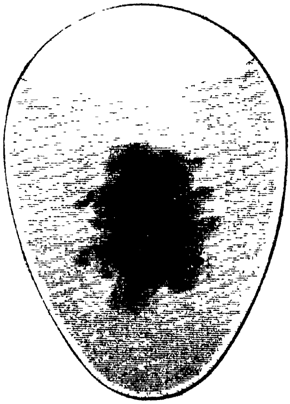


Fig. 92.—Addled Egg

eggs 28 days, duck eggs 28 days, pheasant eggs ys, hen and bantam eggs 21 days.

king Eggs, etc.—The eggs should be put carefully s and kept in this position; they are then more turned over. The average-size egg will give best s. Many eggs go into incubators with a fracture, all that it can hardly be seen before a good light; the eggs as they are being introduced into the drawer

are given a very gentle tap together, a cracked o
instantly detected by the sound. Of course, it is
discarded, although with valuable eggs the fracture sh
be covered over with a small strip of court plaster;
handled carefully they usually hatch. The eggs
be marked on both sides to ensure their being tu
over. A good device is the
one side and an X on the o
With large quantities of eg
incubate, it may be ascert
when they are due by ad
twenty-one days to the
shown on the eggshell.

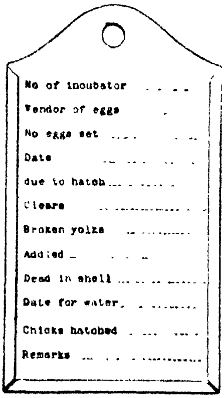


Fig. 93. Card in Holder for Keeping Record

How to Keep Records.–
hatching results should be l
with ease and accuracy.
method described is brief, sim
and correct. Each incu
should be numbered. A
holder having a hole in the top by which to suspend
made to carry some dozen papers. A useful size wo
4½ in. by 3 in., the size of a tradesman's business card
is attached to a nail or tack on the front of each ma
The papers should be written or printed as in Fig

Whatever now is required can readily be fo
Take the tablet off the machine, and enter against
heading what has been done. For instance, if the

amined and five discarded as clears (unfertile), ve in the column for clears. When the hatch is r future reference place this paper fully totalled the tablet holder behind the others. For each se a fresh paper.

ing the Eggs. Do not turn eggs for the first four hours after they have been put in the machine, ng they are cold eggs when inserted. Some move tside eggs to the centre and vice versa. This is because if the machine varies much in different of the egg drawer, many of the eggs undoubtedly e spoils. Therefore they are better left in the same , for then only the outside eggs would suffer. As lears, addled, broken yolks, and dead in shell are ed, so the outside eggs become more towards the , without this changing process. The eggs should rned night and morning by rolling them over. A re and slight push with the finger, and always ds the centre of the drawer, will cause them to turn without shaking them. But if they are revolved ds the sides to move them over, the outer eggs have ng to touch and so are shaken.

is necessary to turn the eggs to prevent the life germs ing to the membrane next the shell. But this turning d be done after cooling instead of before, as is often The lower part of an egg under a hen, or in the ator, is much colder than its upper surface. The

germ always rises to the top whichever way the e moved. Now, by this life germ coming into ss contact with the cold part of the egg, and, besides having to remain to be "cooled" or "aired," it the first stages of its development unable to wit this treatment, and so dies. The hen leaves her n feed, etc.; this allows the eggs to cool gradually. she returns and "shuffles" or moves them, those she does turn do not suffer by their germs rising t upper and cold surface, because the hen is on then soon supplies the necessary heat. This is a most point in incubator management.

Cooling the Eggs.—For the purpose of coolin eggs, open the drawer as wide as possible, and turning the eggs by rolling them over towards the As soon as a few rows are turned, close the drawer i much. Continue the turning, and as more rows are tu close in the drawer, until all the eggs have been tr With large incubators this operation has to be quickly, and the time taken in turning the eggs mo and night cools them sufficiently. The next week al a little longer; the last week from five to fifteen min will be required. The season and weather are great fa to be considered. But here is the proof that will al denote if cooling has been managed properly; see tha th temperature (103°) is back again in an hour. If this tem perature returns in, say, twenty minutes, it means the egg

cooled enough; or if the temperature is not present ours, it proves that the eggs were cooled too much. aps the greatest error is working the incubator igh a temperature, especially during the last three incubation. In such a case the chicks are not lack energy, and do not eat well or thrive. They sily become subject to any disorder or disease.

best temperature in the egg chamber is 103° with of the thermometer not quite touching the eggs. perature of a fertile egg is about 101°.

ginner with incubators is often alarmed to find wentieth morning the heat of the egg drawer up or 106°, and the opened drawer reveals quite a nny, live chicks, this is natural. With good eggs they often hatch on the twentieth day, s or in the machine. The extra heat is from chicks. Some are prone to leave the drawer out ol on this account; this is wrong. Remove the live s, and the surplus heat departs. It is now important aintain the temperature, and many good hatches are t by not being able to get the heat up again after ng out a lot of live chicks.

It should be remembered that at the beginning of a h all the heat comes from the tank; but as the live n in the egg develops, so heat is introduced into the ver, and by taking out live chicks, time must be allowed get the water in the tank hotter.

Moisture for the Eggs.—This is one of the important items in incubator management. A com person is able to tell by the air space what mois wanted and when required. It is very simpl Hold a new-laid egg before an egg-tester, shield with the hands, which is better ack will be noticed that the size of the air cell the egg is only about the size of a threep small air cell is the proof of being qu say, four days the air cell has grown to t pence; in ten days to as large as a shilling The more stale the egg, the larger the air is due to the fact that the egg-shell is porous, a tion is continually going on. Sometimes the at the small end of the egg, or at the side; bu it is at the large end. Here, then, is the vital point regards the air cell and hatching. With new-laid eggs told by the small air cell, put no water for, say, fifteen days. With staler eggs, those with the larger air cell place water in the moisture tray at the beginning. By the means on the nineteenth day the air cells in new-laid and the staler eggs become about the same size, and allow room for the living chick to break its way through the egg shell.

On the nineteenth day it is an excellent plan to have a piece of flannel, cut a trifle larger than the egg drawer wrung out in very hot water, laid rapidly over the eggs, and the drawer closed for ten minutes. Th

ed, if necessary, on the twentieth and twenty-first the chicks seem to be in difficulty, coming out ells through dryness. Lay this quite hot and l over the eggs, and close the drawer for a few Open, and remove the flannel quickly, and n.

incubators allow more moisture than others. ne-hundred egg size, four ½-in. ventilating holes, front, ¾ in. below the tank, will give the best With the non-moisture or hot-air machines, open lators, quarter open at first, and gradually have y open by the nineteenth day, after which time ose them until the chicks are hatched.

to Examine the Eggs.—For examining the eggs, one, large end up, with the points of the fingers thumb of the left hand before a lamp or candle. With right hand partly closed hold it over the top of the This will practically surround it, leaving the back he egg uncovered, for the light to shine through. The ell is shown up quite vivid, and in a fertile egg, the can be distinguished on the fourth day, looking in s of blood, like a spider in its web. The clear or tile eggs should be discarded. This method is better using an egg-testing lamp, many forms of which be found illustrated in dealers' catalogues. The eggs are ined with greater rapidity, they do not come in contact anything cold, and there is a lighted room to work in.

The Drying Box.—This feature of an incubator is useful if properly understood. In the egg chamber there is a moist heat; in the drying box it is dry heat. Chicks should not be left too long in this dry air, or they become excessively thirsty.

How to Manage the Lamp.—The management of an incubator lamp is one of the most important factors in the ultimate success of the machine. The lamp should produce a clear light without smoke or unpleasant smell. Thus it is necessary to have a good, clean burner, best oil, and proper wick. The latter collects from the oil dirt and foreign matter, which make it swollen, hard to wind up and down the wick tube, and the oil is prevented from being freely drawn to the burner.

A new wick should be used every two or three hatches. It is sold prepared and in lengths ready cut. The lamp should be trimmed morning and night. A lamp filled with oil gives much more heat; it need not be turned up so high as the half-empty one, and it is safer to use

Always allow a lamp to burn a little, to see that it is all right. Then before inserting it in the machine lower the flame a trifle; the flue draws the flame a little higher. A lamp turned up high does not smoke when on the table, but it will when put under the flue. More heat is procured from a good, moderate light than a dangerously high flame.

CHAPTER VIII

Various Incubators Described

IN this chapter will be described some leading incubators which, while very far from exhausting the list of commercial machines, will yet be found typical of incubator construction at the present time. They are classified as (1) hydro or hot-water machines, (2) hot-air machines, and (3) combined hydro and hot-air machines. One incubator, in particular, claims to come under the third classification, although, in one sense, all hydro machines can be said to be in that class, as their working depends on both hot water and hot air. Speaking in general terms, the hydro incubator—substantially on the Hearson model—is typical of British machines, and the hot-air incubator—on the "Cyphers" and "Prairie State" models—of the American machines. Of recent years, however, some notable British hot-air machines have been introduced, at least one of them being purely a British production. It will be noted that the leading American makers have agents in England.

Hydro Incubators

Hearson's "Champion" (Spratt's Patent, Ltd., 24 and 25 Fenchurch Street, London, E.C.).—There is no need to

describe this well-known machine fully in this chapter. The hydro incubators described in complete detail in Chapters II. and III. are of the Hearson type, and it must always be remembered that the greater number of hydro machines owe their design to the original Hearson.

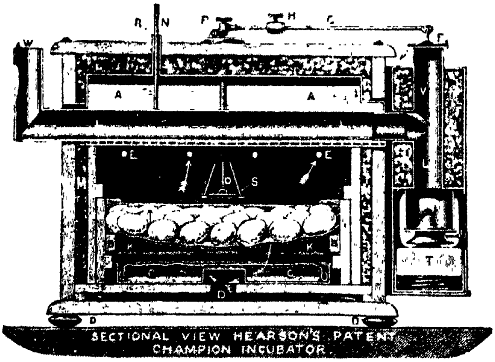


Fig. 94. -Section through Hearson's "Champion" Incubator

It was Charles E. Hearson's invention of the capsule regulator which made possible uniformly successful results with artificial incubation, and on the expiration of the chief Hearson patent in 1895, his design was universally taken up. On the cover of this book is illustrated the Hearson machine It is made in the following sizes:—25-egg, 50- to 60-egg, 100- to 120-egg, and 240-egg. There are special sizes for ostrich eggs, etc.

The section of the Hearson "Champion" machine (Fig.

94) will be familiar to readers of earlier chapters :—A is the water tank; B, moveable egg tray; C, water tray; D, holes for fresh air; E, ventilating holes; F, damper; G, lever; H, lead weight; K, wooden slips; L, lamp chimney and flue pipe; M, non-conducting material; N, tank

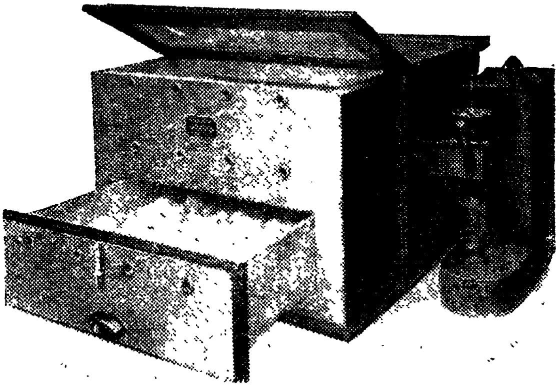


Fig. 95.—Tamlin's "Nonpareil" Incubator

thermometer; O, needle for communicating expansion of capsule S to lever G; P, milled-head screw; R, filling tube; S, capsule; T, paraffin lamp; V, chimney for discharge of surplus heat; W, chimney for discharge of products of combustion.

The action of the capsule is fully gone into in the chapter dealing with regulators, where also the Hearson gas attachments are described. It may be said that

the makers supply the incubator complete and ready for use, except for oil in the lamp, and water in the tank.

Tamlin's "Nonpareil" (W. Tamlin, Twickenham).—This is another high-grade machine, in design typical of the hydro class, and in workmanship everything that

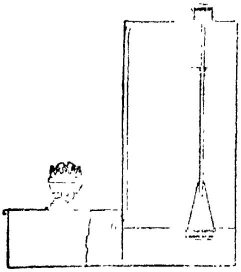


Fig. 96. Tamlin's Automatic Self-supplying Lamp

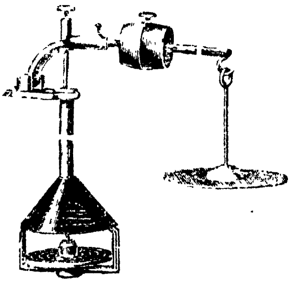


Fig. 97. Everall's Capsule Regulator

it need be. Its sizes (hen egg) are as follow:—30-egg, 60-egg, 100-egg, and 200-egg, besides which there is a 30-ostrich-egg. The maker claims great advantages from the strong construction of the wooden outer and inner cases, the former having brass fittings. The appearance of the 100-egg machine when fitted with drying box and a self- upplying lamp, will be understood from Fig. 95. The shallow tank which, however, retains the same area or radiating surface underneath is a feature of all Tamlin

machines; it is made of 8-lb. hard-rolled copper with four-fold seams. The smallness of the tank capacity is claimed to be a large factor in keeping down the consumption of fuel. The lamp is either of the ordinary kind, or it is of the automatic self-supplying kind shown in diagram by Fig. 96. The container holds enough oil to keep the lamp in use for three or four weeks, and by means of a special device the oil is maintained at the same level around the wick. The regulator is of the capsule type supported in a strong brass stirrup, its speciality being the presence of a conical shield (*see* Fig. 97), made of a non-conducting material which prevents the capsule being influenced by heat radiation from the hot-water tank. The introduction of an insulator prevents any heat conducted by the stirrup from affecting the capsule.

The "Peerless" (H. M. Sheer Company, Quincy, Illinois, U.S.A.).—This has many points of novelty in its design, but it is no reflection upon its undoubted merits to say that it is not likely to be so popular with the British buyer as it is with the American public. It is made in two chief sizes, 100-egg and 200-egg, and the maker sends out the parts and fittings together with full instructions on putting them together. Fig. 98 is a longitudinal section through the essential parts of this machine. Air enters at A, passes between the double walls, and enters the egg chamber at B, where it is warmed by contact with the hot-water tank L. It escapes from the egg chamber

at D, below the eggs, and from the machine at G, passing through flues E and F on the way. The tank is unlike that of any other commercial machine. As shown in Fig. 99, it has heat retaining and distributing bars underneath the tank, and there is a sheet metal deflector (not shown)

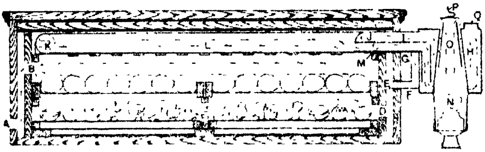


Fig. 98.—Section through "Peerless" Incubator

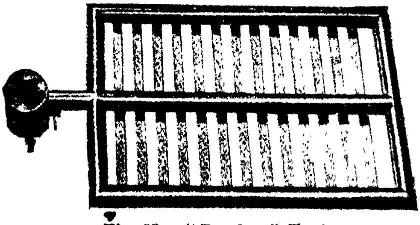
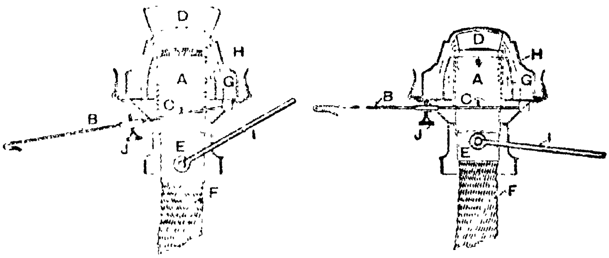


Fig. 99.—"Peerless" Tank

on top. The deflector radiates the heat, the makers say, and the bars absorb it, and, later, distribute it equally to all parts of the chamber. The tank capacity is, of course, comparatively small, and there should be a corresponding saving in fuel consumption. The water, heated in boiler H (*see* Fig. 98), passes through I to the tank cross-tube J, whence it travels in both directions around the outer tubes of the tank, entering the centre tube at K,

returning to the boiler through M. The capsule regulator, of special construction as explained on pp. 95 to 97, ultimately controls the temperature by lifting or lowering the damper P. When P is lifted, all the heat from the lamp flame N passes direct through the central flue O, and escapes under the damper. When P is down, all the heat must pass between the inner flue O and the wall



Figs. 100 and 101.—"Acme" Trip Burner

of the boiler H. Merely a slight lifting of the damper causes part of the heat to pass through O, and the other part between O and H.

The regulator controls the lamp flame as well as the damper, the size of the flame being reduced or increased according to requirements, thus conducing to economy. The "Acme" trip burner is shown by Figs. 100 and 101. It is made throughout of No. 24 gauge brass, pressed and not spun to shape. It has inner and outer domes, which, together with the controlling device, are instantly removable for cleaning. Referring now to Figs. 100 and

101, the former showing the burner with full flame, and the latter with small flame, the wick F is held adjustable in a metal sleeve E connected by a stud to lever I to which is attached the light chain depending from the end of the damper rod (*see* Fig. 77, p. 96). Sleeve A is operated by trip lever B through lug C. D is the flame, G inner dome, and H outer dome. The maker supplies to order an automatic gas valve having a lever corresponding to lever I in Figs. 100 and 101, so that the supply of gas is reduced or increased as the damper rises or falls.

The "Klondyke" (Klondyke Incubator Company, Des Moines, Iowa, U.S.A.). There are many evidences of its American origin in this incubator. It is made in the following sizes (hen egg):—100- to 115-egg, 150- to 165-egg, 200- to 225-egg, and 250- to 290-egg, and an idea of the general construction can be gained from Fig. 102 which shows the incubator with part of the woodwork cut away to reveal the internal arrangement. The hot air from the lamp is conducted through a flue around which is the tubular water tank made of copper. The case is of cypress, lined with non-conducting paper, and is double-walled, with an air space between the walls. The sides, top, and bottom are constructed in the same way. To the egg chamber there is an outer wooden door and an inner glass one. The makers attach great importance to the lamp (the "Oakes Hydro Safety"), shown by Fig. **103**; they say that smokiness and the growth in size of the

flame are due to the upper end of the wick tube becoming hot enough to convert the oil along the sides of the wick into gas, which escapes at both ends of the wick tube, causing liability to explosion and an increase in the size of the flame. In the "Hydro Safety," the wick tube is

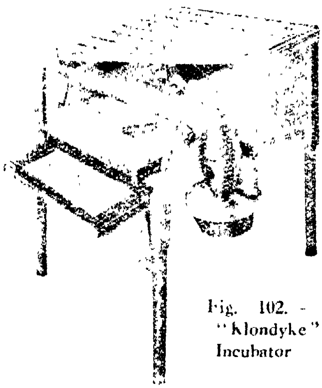


Fig. 102.—"Klondyke" Incubator

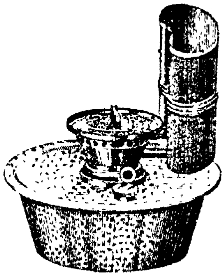


Fig. 103.—"Oakes' Hydro Safety" Lamp

water-jacketed just below its upper end; connection is made through brass tubes to the brass reservoir shown to the right in Fig. 103, so as to ensure a circulation of water around the wick tube.

Beneath the egg tray is the chicken nursery, which is a lower temperature.

Combined Hydro and Hot-air Incubator

The Asbestic Hen (R. Toope and Company, Stepney Square, High Street, Stepney, London, E.).—The speciality of this machine is that the sides, bottom, top, etc., which

in other incubators are made of wood, are in this case made of asbestos board, which does not crack, warp, rot, or harbour vermin, and in addition is a poor conductor of heat and non-combustible. There is an internal packing of much the same nature. The sizes (hen egg) are a follow:—24-egg, 36-egg, 60-egg, 100-egg, 200-egg, and 300-egg. The makers claim advantages from the special system of heating and ventilation, the former being accomplished by hot air and by radiation from a water tank, and the latter by moist heated air automatically supplied. The air entering from outside comes into contact with a hot flue and, in a warmed condition, passes into the egg chamber, down between the eggs to the floor level, thence to the open air up a ventilating shaft whose mouth is fitted with a slide to regulate the amount of air passing through the machine. During hatching time the slide is kept partly closed to retain the moisture necessary for the safe delivery of the chicks from the shells. The machine is heated, as already briefly indicated, by means of a hot-water tank through which passes a double flue. A moist air shaft is at the back of the machine and extends from underneath. The moist air from outside is admitted by this shaft, warmed by being distributed over the tank, and passed down through openings in the tank, and then reaches the eggs which it very slightly moistens. Thence the air passes between the eggs and escapes through the air shaft. The inventor is a firm believer in the theory that in

natural incubation the necessary moisture is supplied by the respiratory organs of the hen's body—not from the ground.

An underneath nursery is a feature of the Asbestic Hen. The chicks on hatching pass from the egg tray to the nursery beneath, where the temperature is the more healthy one of 95° F. At slight extra expense, the machine can be fitted with an internal self-contained electric lamp, thus making it possible to illuminate the interior of the machine merely by pressing a button—a great advantage when requiring to read the thermometer or to observe the progress of hatching. The makers supply on request their "Saivtyme" turning tray with which the eggs can be quickly turned without touching them with the hands. Undoubtedly, the Asbestic Hen is an incubator with many novel but carefully thought-out features, and is well worthy of study.

Hot-air Incubators

The "Cyphers" (Cyphers Incubator Co., Buffalo, New York, U.S.A., and 119 to 125 Finsbury Pavement, London, England).—This is perhaps the best known of all American incubators. It is made in the following sizes (hen egg):—70-egg, 144-egg, 244-egg, and 390-egg. The 244-egg machine, shown in Fig. 104, is typical of all the sizes, except that the smaller ones do not have nursery drawers which, in the illustration, are shown open.

The case is of white pine, the cavity between the outer and inner walls being packed with non-conducting material.

The method of heating is typical of many hot-air machines. The galvanised iron lamp contains a cylindrical brace to prevent buckling of the metal either top or bottom. For the purpose of ensuring a low, clear and steady flame during hot weather, the effective width of the top of the

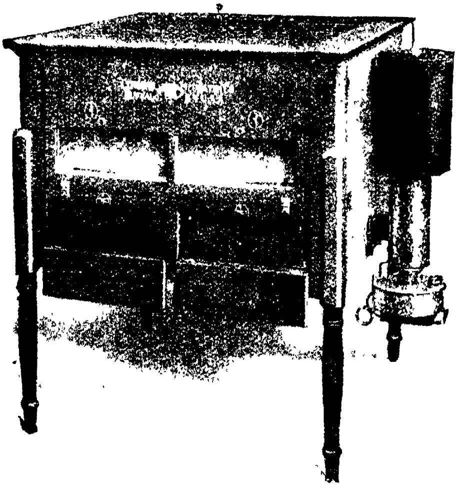


Fig. 104. The "Cyphers" Incubator

wick may be restricted by fitting a flame reducer, which merely slides on friction-tight.

The heater, directly over the lamp, is constructed according to the sectional view shown by Fig. 105, in which I is the main flue exhausting into K, through casting F. The fresh air is admitted through H, where it is warmed by contact with I; and it passes into the body of the

incubator through B, held in the flange casting C. The used air comes back via pipe D and casting E. A is the top cover casting with escape flue L, over which is the damper. An air-spaced asbestos jacket G, 2¼ in. thick, covers the entire exterior of the heater. The warmed, fresh air on being admitted to the body of the incubator is diffused through porous diaphragms, which compose the

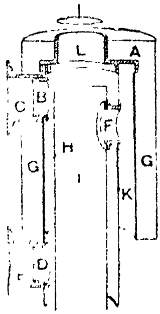


Fig. 105. "Cyphers" Heater

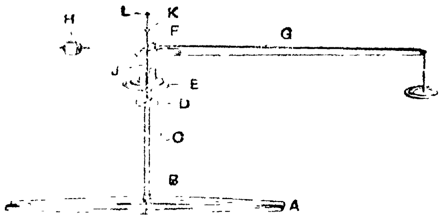


Fig. 106. "Cyphers" All-metal Regulator

upper and lower divisions of the egg chamber. The ventilation is quite automatic after the regulator has been adjusted. The second and third sizes of machine are provided with a drop-bottom; that is, the bottom panel consists of a frame enclosing a hinged bottom, which can be let down to any distance until it touches the floor, thus exposing the under-surface ot the lower felt diaphragm, and facilitating ventilation in hot, dry weather.

The regulator or thermostat is of the all-metal type

(*see* Fig. 106), and is composed of three separate strips, two of zinc and one of steel, all having their long edges bent down at right angles, the zinc strips being notched at the centre. With differences of temperature, the zinc expands or contracts much more than the steel, and therefore the angle formed at the centre of the zinc bars is altered, thus imparting an up or down movement to a vertical connecting-rod, which movement is utilised in the customary manner to raise or lower a damper. In Fig. 106, which represents the thermostat and its connections diagrammatically, the letter references are as follows: A, thermostat; B, brass nipple for attachment of connecting tube C; D, centre guide casting, with base casting E; F, pivot casting to which is attached wooden arm G and counterpoise H; J, connecting-rod with adjusting nut K and lock-nut L.

"**Prairie State**" (Prairie State Incubator Co., Homer City, Pa., U.S.A.; Finch and Fleming, Ltd., Flitwick, Beds).—This machine has a high reputation in Great Britain. The standard machine is now the "sand tray," the principal sizes (hen egg) being 100-egg, 150-egg, 240-egg, and 390-egg. The double walls are made of chestnut, poplar, or pine, the legs being of maple. The packing material is cotton batting and strawboard in alternate layers, the parts of the machine exposed to the greatest heat being insulated by mineral wool and asbestos. The makers guarantee the machine to be fireproof, and state that over a period of twenty years not one of their machines

has caught fire. Much advantage is claimed from the fact that the heat distribution is on the "eddy-current" principle. The eddy-current, the makers say, had the effect in the imperfectly designed machine of causing non-uniform heating, hot spots occurring in the egg-chamber first in one place and then in another; but in the "sand tray" machine the eddy-current is employed as a vehicle for carrying the hot air to the cold parts of the machine. Ventilation is amply provided for, and does not influence the automatic heat distribution, the makers having such faith in the truth of this statement that in their largest machine they use a flat egg tray, which conduces to quick ness and ease of turning. The heater is, as usual, on the outside of the machine, and in its construction it is lapped, seamed, riveted, and soldered. Any soot deposits, should they occur, can be readily removed. It is insulated with an asbestos jacket covered with a neat hood, its exhaust being a small round pipe so arranged that the lamp fumes can be taken directly into the outer air.

A current of warm pure air enters the machine from the heater, and is forced continuously through the egg chamber, but from this point onwards the ventilation is on a different principle from what is customary. The heating current goes down part of the way in the egg chamber, and passes through apertures in the walls above the eggs; consequently there is a direct current only in the upper part of the egg chamber, the actual ventilation of the eggs being

caused by molecular diffusion. The air, having passed through the apertures in the walls, flows downward into a space under the nursery, where it is released, thoroughly warming the bottom of the machine and then passing away through holes to the outside air. The eggs do not receive any bottom heat, the warm air current merely warming the nursery to a temperature of from 85 to 90° F., depending upon the temperature of the room. The entire bottom of the machine is occupied with a galvanised iron pan containing wet sand; this moisture is being constantly given off underneath the eggs, which, according to the makers, is a very close approach to the natural conditions found with the hen. At the end of the incubator is a suction tube communicating with the bottom of the chicken nursery and opening into the outside air; by its means, whenever desired, a current of air can be sent through the eggs and nursery with the object of carrying off moisture and hardening the chicks during the latter part of the exclusion period. The regulator, patented as recently as 1907, comprises a special design of steel-zinc thermostat. The attachment to the regulator rod is at the extreme end of the device, and not, as in the majority of metal thermostats, at the middle.

Below the egg trays is the nursery, into which the chicks fall through an aperture formed by removing a loose slip at the front. The bottom of the nursery is covered with a canvas mat tacked to a light removable

frame, the back part of which is a wide board; by means of this frame the chicks can be withdrawn.

The "Gloucester" (The Gloucester Incubator Company, Gloucester).—This is a well-made machine of British manufacture, although in many respects reminiscent of American design. It is made in the following sizes (hen egg): 40-egg, 66-egg, 100-egg, 150-egg, 250-egg, and 390-egg. It has a well-made case, the outer walls being

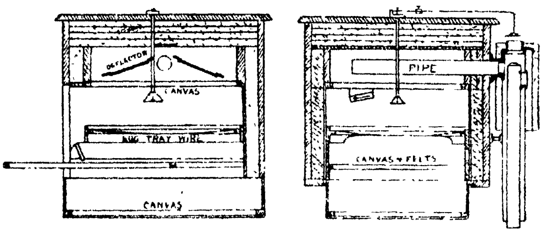


Fig. 107 and 108. Sections through "Gloucester" Incubator

made of kiln-dried and tongued very narrow boards, mortised and tenoned and screwed and glued together; the theory, based on a generally known fact, is that the narrower the boards the less is the trouble from shrinkage. In the cavity between the double walls is packed laminated vegetable cotton; and in places, notably over the heating pipes, the insulation takes the form of layers of cotton-wool between strawboards, the whole being greatly compressed. For heating the incubator, the lamp is supported at the side of the machine, as in a hydro incubator, insulated therefrom by means of asbestos lagging. The

lamp, by means of a toggle lever device, can be either fixed or removed with the utmost ease ; the bracket forms a support upon which the lamp can remain while trimming and filling. The makers have adopted a special form of burner and a self-filling lamp ; in the latter the oil is kept automatically at a uniform level, it being possible to remove the reservoir to get at the burner if desired. The special burner comprises a mechanical wick trimmer, by means of which the wick can be trimmed in an instant without moving the lamp.

The heater itself is of the type illustrated by Fig. 105, p. 133.

Figs. 107 and 108 show two sections through the incubator. The pipe introducing the warm air will be noticed. The deflector or defle directs the air over a double porous diaphragm of canvas, and into the egg-chamber in which the eggs lie upon a wire cloth tray sloping towards the centre. The air passes down through the machine, and ultimately escapes at the bottom. By the use of removeable felts below the eggs, the amount of air passing through the machine is easily controlled. The lower felt is partly exposed to the outside air, this being a factor in maintaining correct humidity.

Between the front of the egg tray and the door by which the chicks find access to the nursery beneath is a space of about 3 in., occupied until, say, the first or second testing with a movable wooden slip upon which eggs may

be placed. When "pipping" starts, the slip is removed. The chicks on hatching are attracted by the light, and in moving towards it they drop down upon a sliding platform. There is no need to take out the drawer and transfer the chicks from egg-chamber to nursery. The platform is slowly withdrawn, so causing the chicks to drop into a drawer having a stretched canvas bottom. The use of this arrangement obviates the temptation to open the door during a hatch, and consequently cooling the chamber.

The "New Buffalo" (Buffalo Incubator Company, Buffalo, New York, U.S.A.).—This incubator is the production of Charles A. Cyphers, and follows in very many respects the well-known Cyphers models. The sizes are :— 50- to 60-egg, 110- to 120-egg, 220- to 240-egg, and 340- to 360-egg. The case is made of galvanised iron lined with fibre-board ; the cavity between the double walls is filled with non-conducting material. The front is of hard wood, with both wooden door and glass door to egg-chamber. The heater is on the Cyphers model, its casing being of asbestos enclosed in a galvanised-iron jacket. The heating and ventilating system is on the Cyphers style. The regulator is of metal. Wire-cloth egg-trays are employed.

CHAPTER IX

Chicken Rearers or Foster-mothers

For chickens that have been hatched by artificial means a substitute for the natural mother is a prime necessity during the first few weeks of their lives. If strong, hardy birds are to be ensured, coddling must be avoided; yet, until the chicks have their feathers, they must be provided with a well-warmed retreat to which they can have access at will. Free ventilation must be provided, but draughts must be guarded against; there must be no corners into which the chicks may huddle; and the heat source should, if possible, be central.

All the leading incubator manufacturers have their own special designs of rearers, which, in the majority of cases, can be depended upon. The purpose of this chapter is not to describe the many commercial rearers, but to give plain instructions on making some rearers which have answered excellently in practice.

100-chick Rearer with Run.—The foster-mother shown in Fig. 109 is heated by a tank similar to an incubator tank, the lamp being in a separate compartment. The run is made separate from the hot chamber, the foster-mother proper, and is secured to it by a couple of

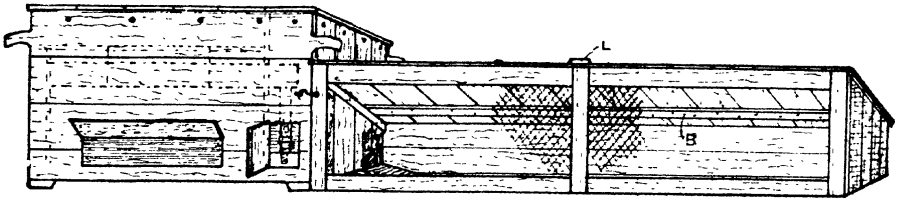


Fig. 109.—Front View of Rearer

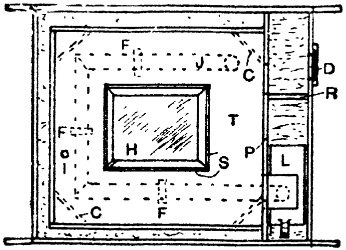


Fig. 110.—Horizontal Section through Rearer.

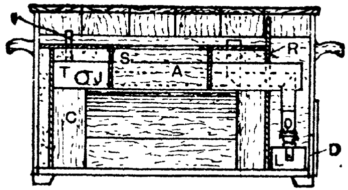


Fig. 111.—Vertical Section through Rearer

hooks, with staples to match. By unhooking, the chamber and chicks may be moved by the handles shown in Figs. 109 to 111, and may be so carried indoors nightly in very cold or stormy weather, if deemed advisable. Fig. 112 shows an end view.

The length over all is 10 ft., of which the run measures 6 ft. 10 in. and the hot chamber 3 ft. 2 in. The extreme width is 2 ft. 10 in.

The tank T is of zinc throughout, except the flues, which are of 8-lb. copper, and is 2 ft. 6 in. wide by 2 ft. 4 in. long, plus the flue extension into the lamp chamber, which is 5 in. long by 4½ in. wide. The tank is clearly shown in Figs. 110 and 111. It is 3¼ in. deep, and has flues J of 2-in. diameter extending round three of its sides (*see* Fig. 110). These flues are secured ½ in. from the bottom plate with three small feet formed by soldering strips of zinc ¾ in. wide to the flues, bending them down to the form shown in Fig. 113, then soldering them in place on the bottom as indicated at F (Fig. 110). A filling tube I, ¾ in. in diameter, is provided.

An aperture A through the tank measures 1 ft. 4 in. by 1 ft. 1 in. It is lined with strips of wood S (Fig. 110) 5 in. wide and ½ in. thick. To these strips is fitted and hinged a glazed door H, which gives a clear view of the interior, and allows access for cleaning out, etc. The corner pieces C support the tank and are 9 in. high by 6 in. wide, the tank being 9 in. from the chamber floor.

The inner walls are made to fit the tank body, one end being long enough to extend across to the outer walls, thus forming the partition wall P of the lamp chamber. The outside walls measure 3 ft. 2 in. long by 2 ft. 10 in. wide over all, and are 2 ft. high at the front, sloping to 1 ft. 8 in. at the back, and are ⅞ in. or 1 in. thick. A hinged top covers all. A door for cleaning purposes, 1 ft. 8 in. long by 4½ in. wide, is provided, and another 5 in. by 6 in., gives access to the lamp.

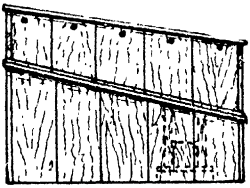


Fig. 112.—End View of Rearer

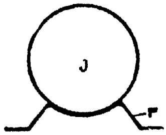


Fig. 113. – Section through Rearer Flue, showing Feet

The lamp chamber is 5¼ in. wide, and has a cross partition R to prevent the chicks reaching the lamp L while passing in and out of the doorway D. The lamp is 11 in. long by 2½ in. deep, and of a width to fit its compartment loosely. It has a 1-in. burner and a loose metal chimney having a turned-in lapped or riveted joint and a mica-covered peep-hole. The tank and side spaces are packed with sawdust to the level of the strips S, and are covered in with ½-in. pine.

A doorway D to the hot chamber, 4½ in. wide by 5 in. high has a door sliding in guides, which can be lowered

at night. A small gangway about 7 in. wide slopes from the door level to the run floor.

The run is 1 ft. 8 in. high at the front, sloping to 1 ft. at the back (*see* Fig. 112). The roof is hinged in two lengths, the joint being covered by a strip L (Fig. 109), 3 in. by ½ in., secured to one-half, so as to lap over. Two 4-in. battens (one, B, only being visible inside the roof at Fig. 109) run the full length of each roof section, and are well secured with nails driven through and clinched. The front frame is in one piece, and is covered with wire netting of ½-in. mesh.

An ordinary thermometer should be hung in the chick chamber, and the temperature should be for the first week 90°, the second week 80°, and the third week 70°; but if the weather is warm 5° or 10° lower will be ample for the first fortnight. These temperatures are better for outdoor rearing. The foster-mother should face south in fine weather, but be turned with back to the rain.

60-chick rearer.—Another style of rearer is shown in Figs. 114 to 116. The woodwork is composed of matchboards and scantling. To accommodate sixty chicks the rearer may be 7 ft. long, 2 ft. wide, and 2 ft. high at the back, and 2 ft. 6 in. high in the front. The matchboards are 6 in. by ⅜ in. all through, and the scantling is 4 in. by 1 in. The back will require fourteen matchboards, 2 ft. by 6 in. by ⅜ in. The lengths of scantling are: Two pieces for the back legs, 2 ft. by 4 in. by 1 in.; two pieces

for the front legs, 2 ft. 6 in. by 4 in. by 1 in.; two pieces for each end, 2 ft. by 4 in. by 1 in.; two pieces to form back and front rails at the bottom, 7 ft. by 4 in. by 1 in.; and two pieces to form the top rail, from the ends of which the handles are formed. The top rails must be 7 ft. 6 in. by 4 in. by 1 in.; therefore 42-ft. run will be required. The two ends of the rearer are alike (*see* Fig. 116). The sleeping place is 2 ft. square. A partition (Fig. 117) is

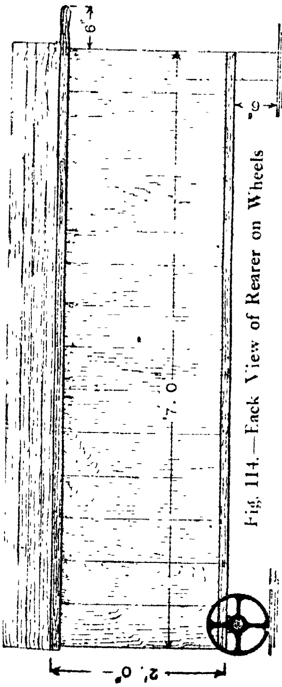


Fig. 114.—Back View of Rearer on Wheels

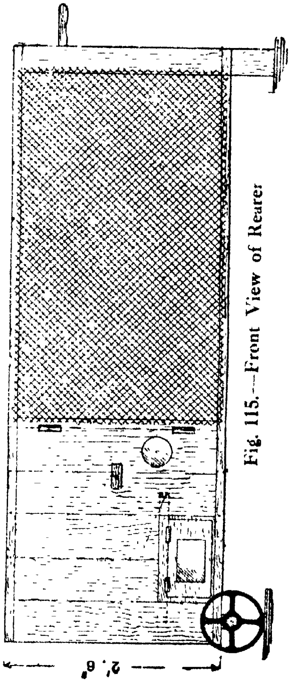


Fig. 115.—Front View of Rearer

fixed 2 ft. from one end, and another partition 6 in. from it, thus leaving a space of 6 in. in which the lamp slides, but there must be a hole cut in the two pieces for the chicks to pass through from the run to the sleeping place behind the end of the lamp.

The rearer is mounted on two 9-in. cast-iron trolly wheels, which are fixed at the opposite end to the handles; thus the rearer is easily wheeled to fresh ground. These

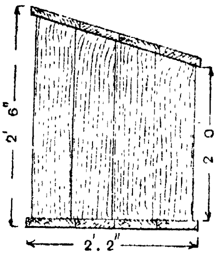


Fig. 116.--End View of Rearer

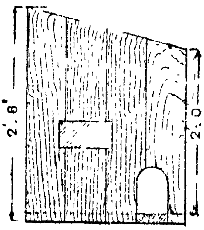


Fig. 117.—Partition for Rearer

wheels run on a piece of gas barrel about 2 ft. 6 in. long, which is fixed by means of two plate staples 1 in. wide, which are screwed to the scantling. The ends are fixed to the back and front by 4-in. cut nails driven in on the skew. To fix the floor, two 2-in. by 1-in. fillets are nailed the full length of the rearer, and the matchboard is nailed down to it.

The top is made in two parts; one covers the sleeping place and lamp shelter, and the other covers the run. The top should be 7 ft. 6 in. long and 3 ft. wide, thus lapping all round to run the rain well off.

The tank should measure 1 ft. 10 in. square by 3 in. deep, and must be placed with its bottom 9 in. above the floor. Its central hole is 1 ft. square, so that the birds can be got at from the top and the rearer itself cleaned out. Stout sheet zinc, say No. 11 or No. 12 s.w.g., answers the purpose, but copper is to be preferred. It is cut on the lines of Fig. 118, and bent at right angles, thus forming the bottom of the tank. The top of the tank is cut in the same way in the centre. Thus two sides are formed

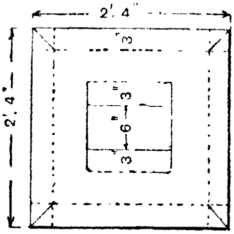


Fig. 118.—Pattern for Rearer Tank

of the centre hole out of the top, and two sides out of the bottom. This tank must be well soldered together.

The flow and return copper pipes, $\frac{1}{2}$ in. in diameter, are next fixed to the boiler and tank, as shown in Fig. 119, and a small tank is fixed on top of the large one for filling, and must always be kept full so that the jacket boiler C and large tank are also full. An air pipe is fixed beside the small tank, and stands 1 in. above it. The filling pipe dips 1 in. into the large tank, but the air pipe must be fixed flush on the top of this tank to allow the air to get

away and prevent the water getting air-locked. The small supply tank is 3 in. by 2 in., and both pipes are ½ in. in diameter. The return pipe must have a dip in it as at A (Fig. 119), and this will prevent the hot water flowing up it. Fig. 120 shows the inside portion of the boiler, and the two pipes B must be soldered in place before sliding this part into the outer jacket. About ½ in. space between the inner and outer cases is sufficient. The two ventilating tubes are ¾ in. long by ½ in. in diameter.

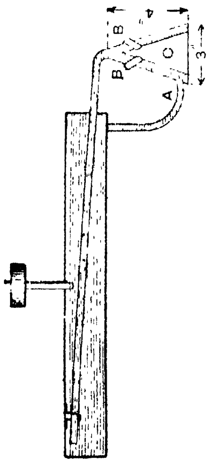


Fig. 119.—Rearer Boiler and Tank

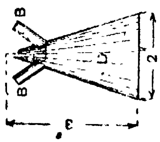


Fig. 120.—Inner Part of Rearer Boiler

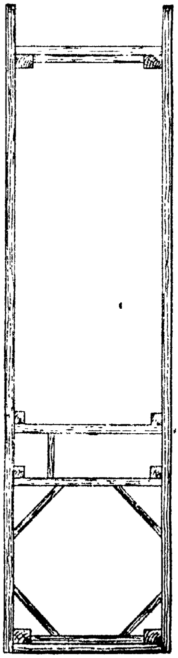


Fig. 121.—Plan of Rearer Frame

The tank and boiler being ready, next fix in each corner of the sleeping place a length of wood 9 in by 6 in. wide. These pieces (*see* the plan, Fig. 121) shut off the corners, and so prevent the birds getting crushed to death in the corners, which is so often the case when square sleeping places are used. Thus a resting-place is made for the tank, and a 1-in. space is left all round the tank to be filled with sawdust or silicate of cotton. A 1-ft.

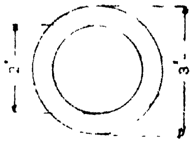


Fig 122.—Copper Ring for Rearer Boiler

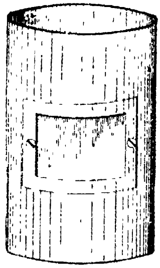


Fig. 123. Burner Chimney

square frame 3 in. deep is now fitted tightly into the square hole in the middle of the tank and allowed to stand up 1 in. above the surface. Next fill in all over the tank with sawdust to keep the heat in, and nail a ½-in. fillet all round the inside of this frame, say 1 in. down, on which a wooden lid rests. This lid can be easily removed for cleaning-out purposes or for attending to the chicks from the top of the rearer.

A copper ring (Fig. 122) is cut and passed over the top of the part shown by Fig. 120 and soldered round the

bottom of it. The inner portion of the boiler D (Fig. 120) is now placed inside the outer jacket, and the ring soldered to the bottom edge of the outer jacket, thus forming the bottom of the jacket. The partition for the sleeping place should have a glass in it just under the boiler, so that the lamp lights the sleeping place; a hole should also be made in the farther corner at the back.

With regard to the distance of the burner from the end of the lamp, the collar of the burner should be soldered on about 1 in. from the end of the petroleum container; but it will be better to get the cone boiler in place first, and then to put the burner underneath the middle of the cone. The best burner to use is a 1-in. Queen Anne.

The chimney may be constructed of thin tinplate, the diameter being the same as that of the burner gallery; the height is regulated by the distance between the bottom of the boiler and the burner, usually 4 in. An oblong hole is cut in the tin, about 2 in. long by $1\frac{1}{2}$ in. deep. A piece of mica is placed over this hole (*see* Fig. 123). A brass frame fixed to the chimney by means of a fender screw and nut at each end keeps the mica in position; thus it is possible to see the flame without opening the door.

The height of the chimney will depend on the depth of the lamp. If the lamp is 1 in. deep and the burner 1 in., then 3 in. will be left between the boiler bottom and the rearer floor; in that case the chimney would be $2\frac{3}{8}$ in. high, thus allowing $\frac{1}{8}$ in. clear between the top of

the chimney and the bottom of the boiler. The lamp may be 1 ft. 6 in. long, 4 in. wide, and 1 in. deep.

• **A cold brooder**, into which the chicks may be turned when fledged, and when no longer in need of artificial heat, is shown in Fig. 124. This period cannot be arbitrarily fixed, as much will depend upon the state of the weather, but from three to six weeks old may be taken as the

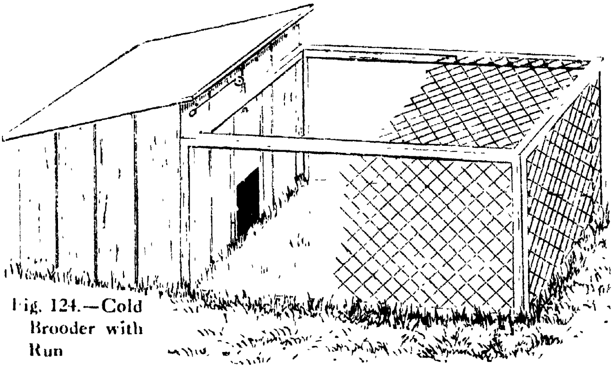


Fig. 124.—Cold Brooder with Run

average age at which artificial heat may be dispensed with. This brooder may be 2 ft. square, the same in height at back, and 6 in. higher in front; and the run 4 ft. long and 14 in. high. The house portion can be constructed of matchboarding with the whole of the back hinged with cross garnets to open, and for the framing of the run 2-in. by 1-in. slate batten will be just the thing. If the top of this is hinged as in Fig. 124, it will be found a convenience for inserting food and water.

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